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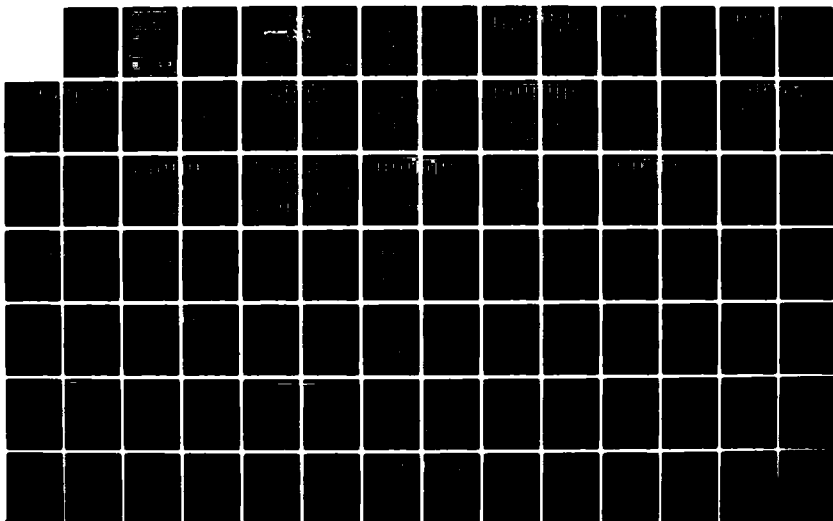
CONSTRUCTION FOUNDATION REPORT MISSOURI RIVER GARRISON  
DAM LAKE SAKAKAWEA VOLUME 2 DRAWINGS(U) ARMY ENGINEER  
DISTRICT OMAHA NE NOV 83

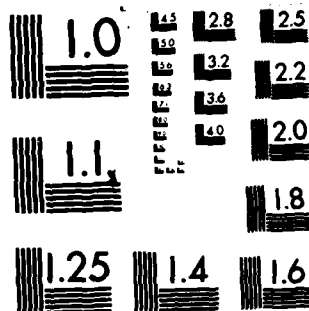
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

AD A140035

# CONSTRUCTION FOUNDATION REPORT

③

## MISSOURI RIVER GARRISON DAM - LAKE SAKAKAWEA

### VOLUME II DRAWINGS

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NOVEMBER 1983



US Army Corps  
of Engineers  
Sacramento District  
Sacramento, California

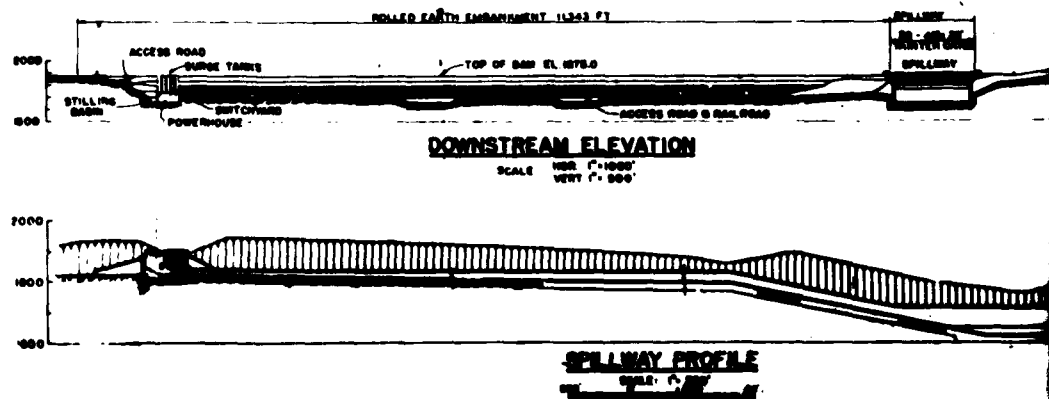
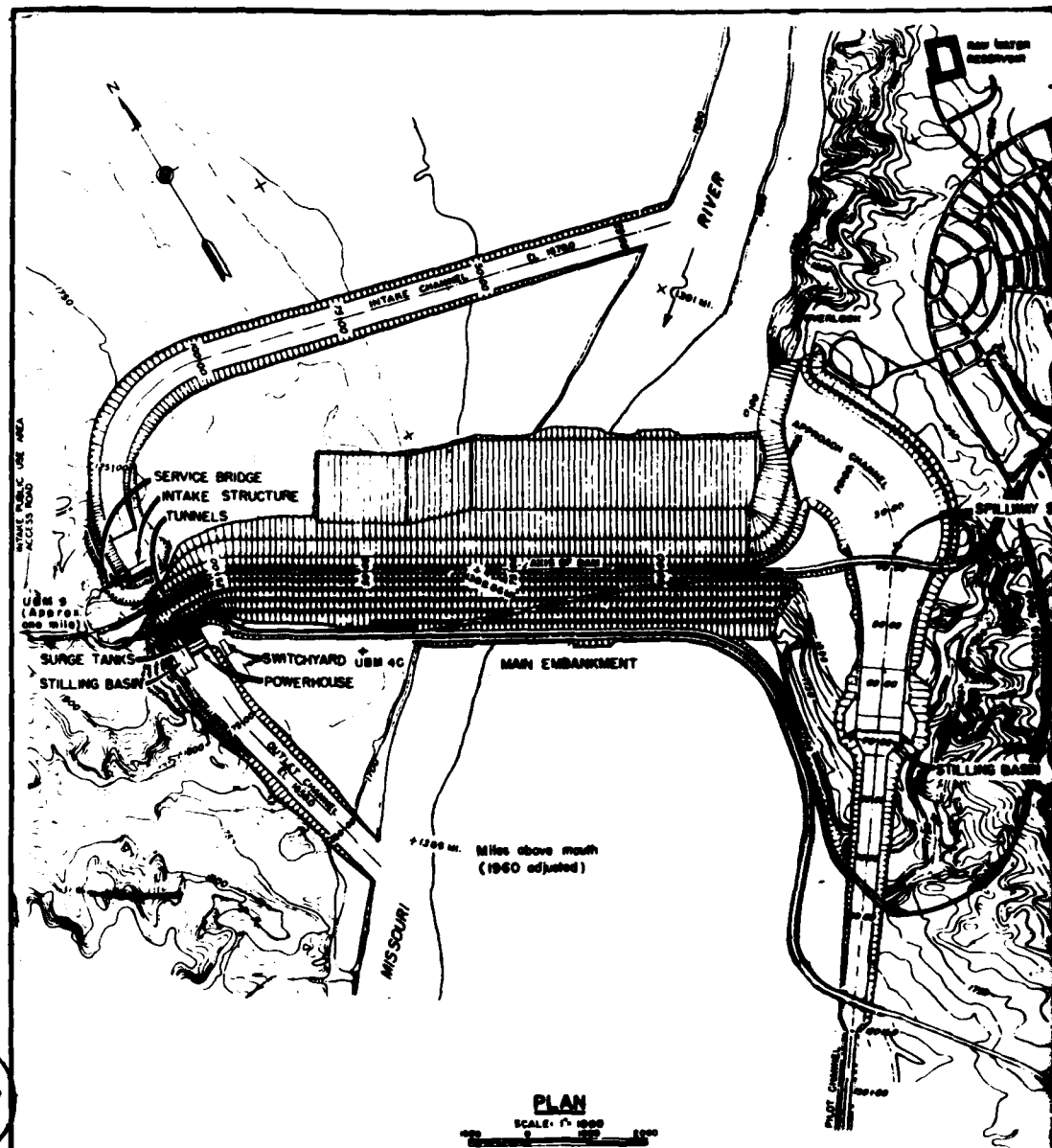


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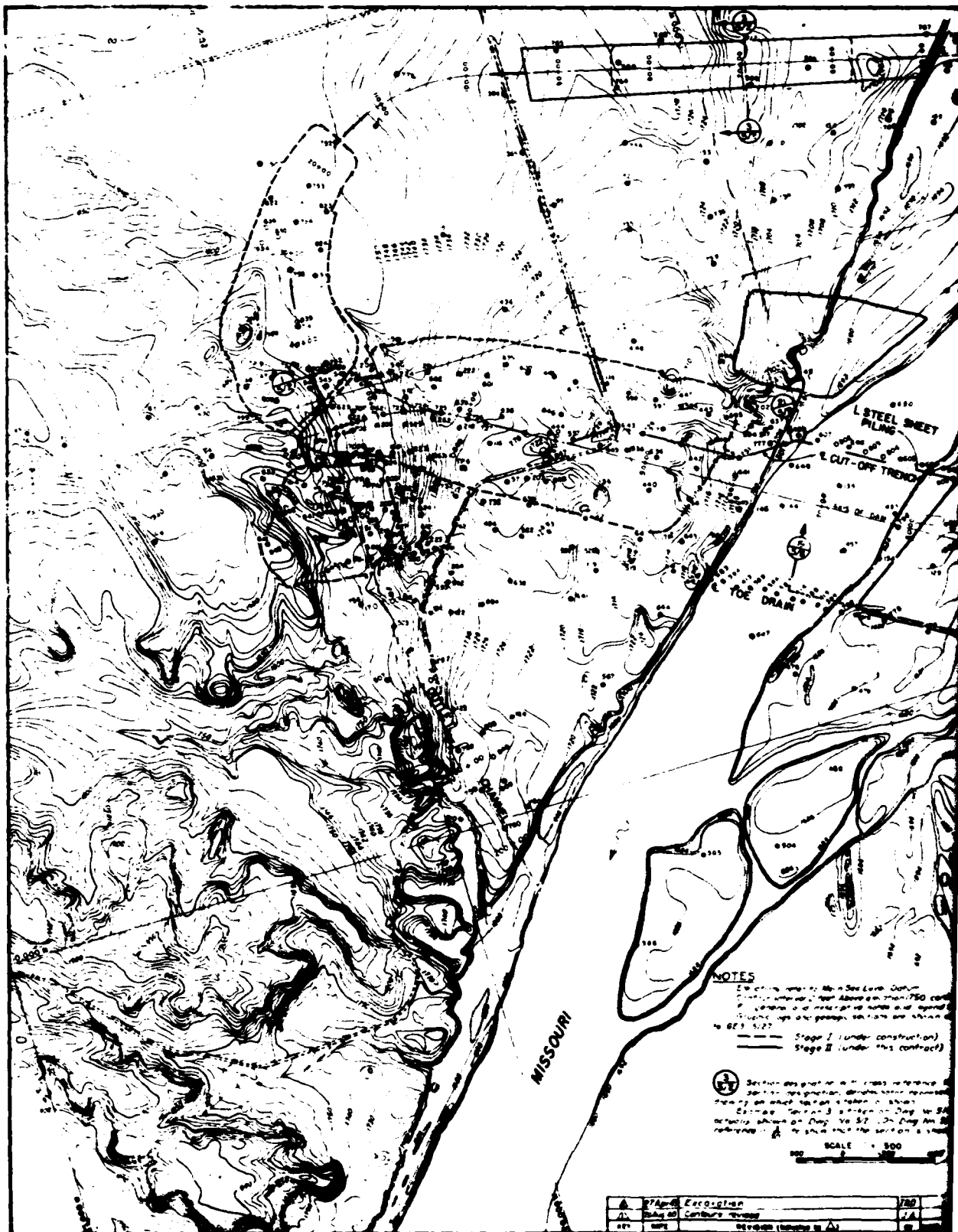
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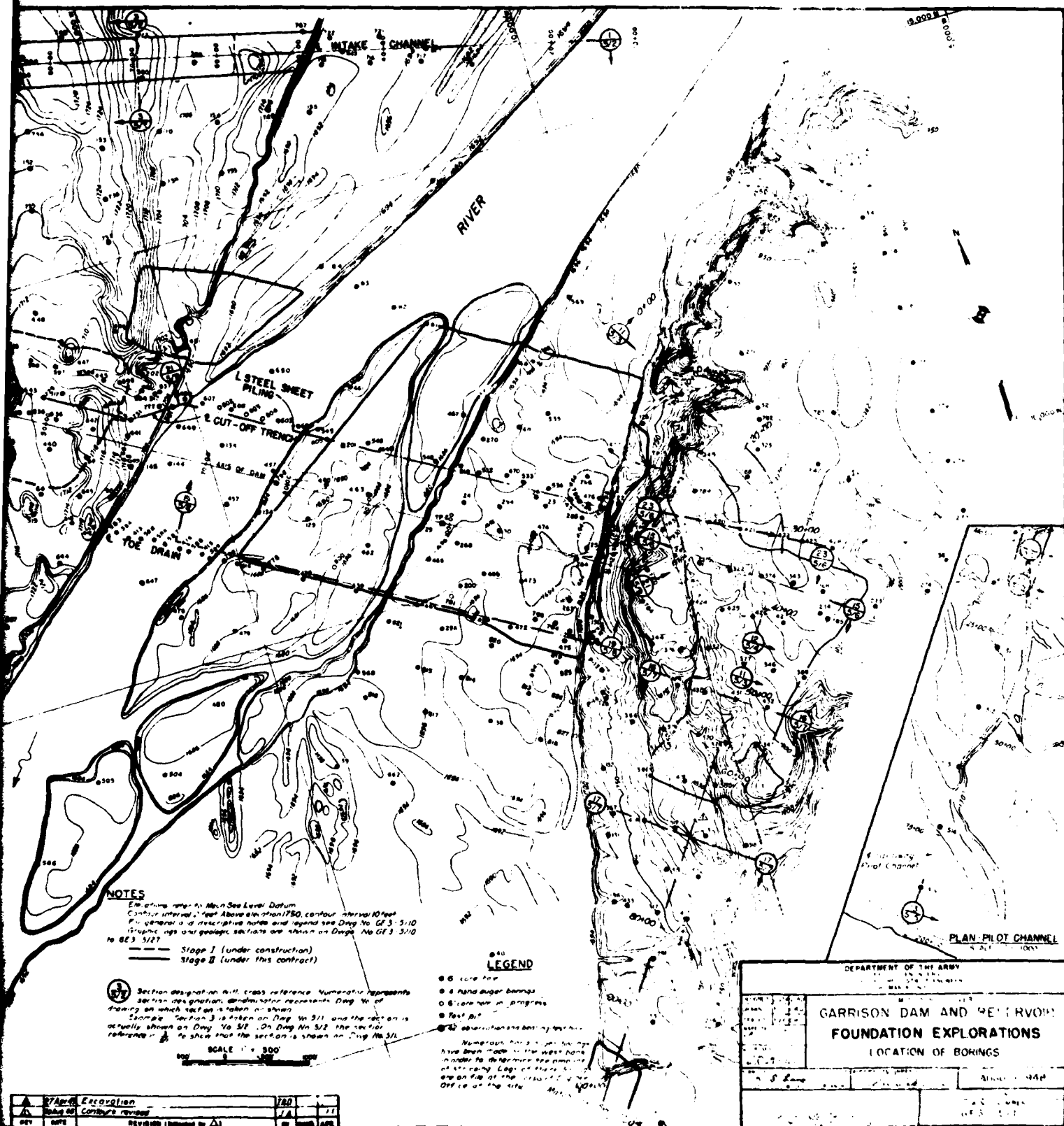
A-1

23

24







Geological cross-section of the New York Bight area, showing five boreholes (22, 23, 24, 25, 26) with depth in feet on the left and geological descriptions on the right. The section shows various sediment types like sand, clay, loam, and gravel, with specific depth markers and labels for each borehole.

**Borehole 22 (1 MAY 43 1743.5):**

- 0 - 10: Red Clay
- 10 - 20: silty loam
- 20 - 30: red clay
- 30 - 40: silty clay
- 40 - 50: L. 12'
- 50 - 60: CL 5'
- 60 - 70: CL 2.5'
- 70 - 80: L. 0.4'
- 80 - 90: CL 1.8'
- 90 - 100: CL 1.8'
- 100 - 110: CL 3.0'
- 110 - 120: CL 3.0'
- 120 - 130: L. 0.5'
- 130 - 140: Clayey sil.
- 140 - 150: Ei 1502.5

**Borehole 23 (3 MAY 43 1594.5):**

- 0 - 10: Red Clay
- 10 - 20: silty clay
- 20 - 30: silty loam
- 30 - 40: sandy loam
- 40 - 50: Sand
- 50 - 60: Gravel
- 60 - 70: gravel loam
- 70 - 80: Gravel
- 80 - 90: sandy gravel
- 90 - 100: Sand
- 100 - 110: Sand
- 110 - 120: clay loam
- 120 - 130: Gravel
- 130 - 140: Gravel & boulders
- 140 - 150: mud clay
- 150 - 160: L. 21'
- 160 - 170: CL 4.8'
- 170 - 180: Ls 0.2'
- 180 - 190: Ei 1554.5

**Borehole 24 (5 MAY 43 1587.4):**

- 0 - 10: Red Clay
- 10 - 20: sandy loam
- 20 - 30: Sand
- 30 - 40: Sand
- 40 - 50: sandy gravel
- 50 - 60: Sand
- 60 - 70: Sand
- 70 - 80: grav. sand
- 80 - 90: sandy loam
- 90 - 100: Sand
- 100 - 110: Sand
- 110 - 120: Sand
- 120 - 130: Silty clay loam
- 130 - 140: Sand
- 140 - 150: Silty clay loam
- 150 - 160: Silty loam
- 160 - 170: Silty loam
- 170 - 180: Silty loam
- 180 - 190: Silty loam
- 190 - 200: Silty loam
- 200 - 210: Silty loam
- 210 - 220: Silty loam
- 220 - 230: Silty loam
- 230 - 240: Silty loam
- 240 - 250: Silty loam
- 250 - 260: Silty loam
- 260 - 270: Silty loam
- 270 - 280: Silty loam
- 280 - 290: Silty loam
- 290 - 300: Silty loam
- 300 - 310: Silty loam
- 310 - 320: Silty loam
- 320 - 330: Silty loam
- 330 - 340: Silty loam
- 340 - 350: Silty loam
- 350 - 360: Silty loam
- 360 - 370: Silty loam
- 370 - 380: Silty loam
- 380 - 390: Silty loam
- 390 - 400: Silty loam
- 400 - 410: Silty loam
- 410 - 420: Silty loam
- 420 - 430: Silty loam
- 430 - 440: Silty loam
- 440 - 450: Silty loam
- 450 - 460: Silty loam
- 460 - 470: Silty loam
- 470 - 480: Silty loam
- 480 - 490: Silty loam
- 490 - 500: Silty loam
- 500 - 510: Silty loam
- 510 - 520: Silty loam
- 520 - 530: Silty loam
- 530 - 540: Silty loam
- 540 - 550: Silty loam
- 550 - 560: Silty loam
- 560 - 570: Silty loam
- 570 - 580: Silty loam
- 580 - 590: Silty loam
- 590 - 600: Silty loam
- 600 - 610: Silty loam
- 610 - 620: Silty loam
- 620 - 630: Silty loam
- 630 - 640: Silty loam
- 640 - 650: Silty loam
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- 660 - 670: Silty loam
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- 680 - 690: Silty loam
- 690 - 700: Silty loam
- 700 - 710: Silty loam
- 710 - 720: Silty loam
- 720 - 730: Silty loam
- 730 - 740: Silty loam
- 740 - 750: Silty loam
- 750 - 760: Silty loam
- 760 - 770: Silty loam
- 770 - 780: Silty loam
- 780 - 790: Silty loam
- 790 - 800: Silty loam
- 800 - 810: Silty loam
- 810 - 820: Silty loam
- 820 - 830: Silty loam
- 830 - 840: Silty loam
- 840 - 850: Silty loam
- 850 - 860: Silty loam
- 860 - 870: Silty loam
- 870 - 880: Silty loam
- 880 - 890: Silty loam
- 890 - 900: Silty loam
- 900 - 910: Silty loam
- 910 - 920: Silty loam
- 920 - 930: Silty loam
- 930 - 940: Silty loam
- 940 - 950: Silty loam
- 950 - 960: Silty loam
- 960 - 970: Silty loam
- 970 - 980: Silty loam
- 980 - 990: Silty loam
- 990 - 1000: Silty loam
- 1000 - 1010: Silty loam
- 1010 - 1020: Silty loam
- 1020 - 1030: Silty loam
- 1030 - 1040: Silty loam
- 1040 - 1050: Silty loam
- 1050 - 1060: Silty loam
- 1060 - 1070: Silty loam
- 1070 - 1080: Silty loam
- 1080 - 1090: Silty loam
- 1090 - 1100: Silty loam
- 1100 - 1110: Silty loam
- 1110 - 1120: Silty loam
- 1120 - 1130: Silty loam
- 1130 - 1140: Silty loam
- 1140 - 1150: Silty loam
- 1150 - 1160: Silty loam
- 1160 - 1170: Silty loam
- 1170 - 1180: Silty loam
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- 1190 - 1200: Silty loam
- 1200 - 1210: Silty loam
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- 1240 - 1250: Silty loam
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- 1260 - 1270: Silty loam
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- 1290 - 1300: Silty loam
- 1300 - 1310: Silty loam
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- 1360 - 1370: Silty loam
- 1370 - 1380: Silty loam
- 1380 - 1390: Silty loam
- 1390 - 1400: Silty loam
- 1400 - 1410: Silty loam
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- 1480 - 1490: Silty loam
- 1490 - 1500: Silty loam
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- 1580 - 1590: Silty loam
- 1590 - 1600: Silty loam
- 1600 - 1610: Silty loam
- 1610 - 1620: Silty loam
- 1620 - 1630: Silty loam
- 1630 - 1640: Silty loam
- 1640 - 1650: Silty loam
- 1650 - 1

**Faci Lignite Formation.** is an immature stage consisting of a series of continually deposited, consolidated, clayey to sandy materials, arranged in gently dipping beds (often cross bedded), which range from thin partings to 15' or more in thickness. Clayey lignites are present in the lower part of the formation. They are also present within the formation, bands of lignite which may attain a thickness of 5' or more, and numerous beds of lignite coal varying in thickness from thin partings to over 10 feet.

The lignite is found in places colored and hard-panned adjacent material. When exposed these have a pinkish color and are locally known as escoria.

The lignite facies formation is an unsorted mixture, graded largely from sand sizes to clay sizes, locally deposited in a somewhat stratified manner, but with a small percentage of pebbles having a usual maximum size of six inch.

Lignite facies indicates the presence of various sized pieces of lignite transported and mixed by stream action and found deposited in varying concentrations at irregular intervals throughout the entire thickness of the formation.

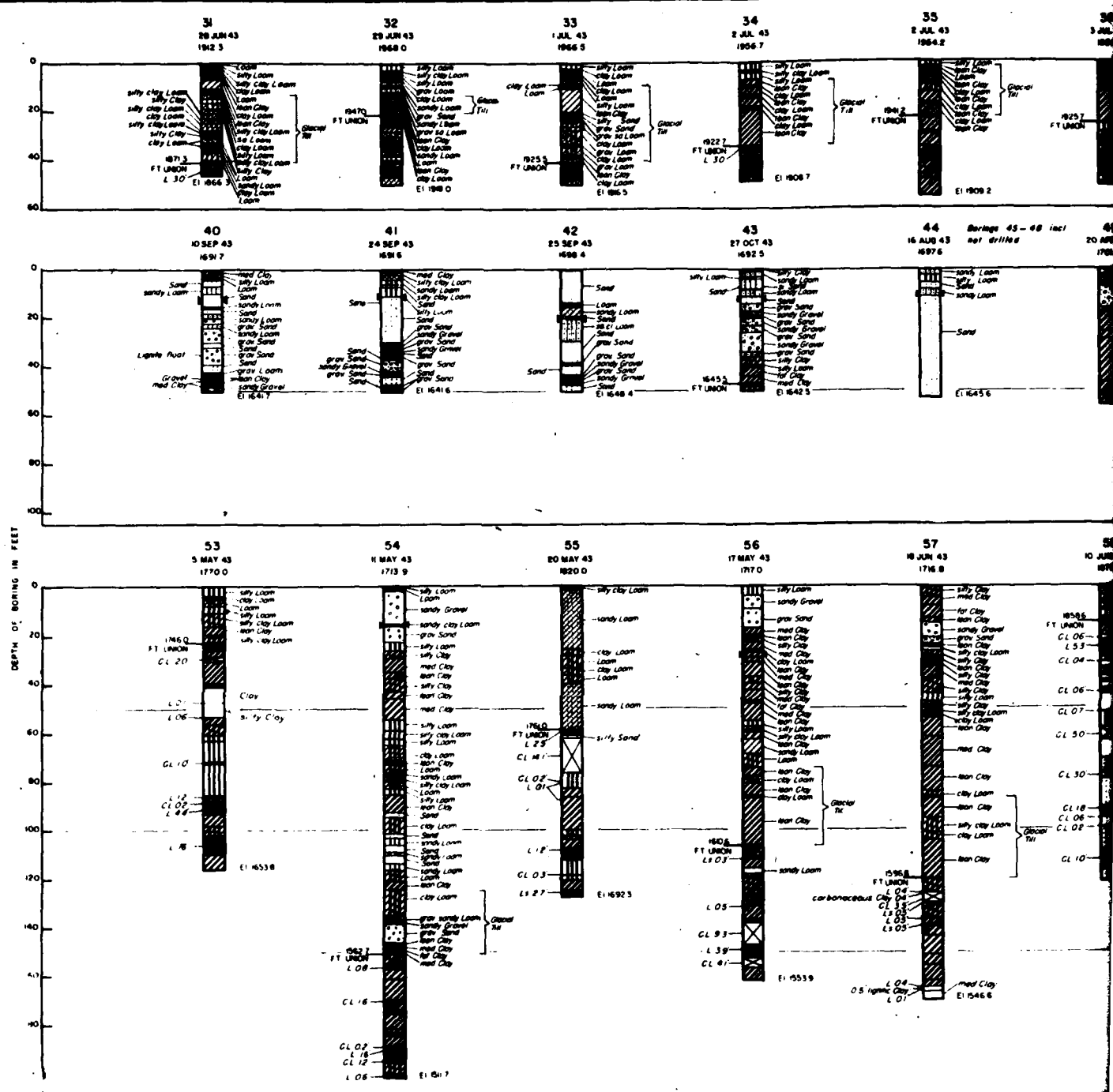
The term lignite is used to designate a mixture of sand, silt and clay when the percentage of clay sizes ranging from 0 to 15 for loess and from 20 to 25 for clay loam, with the percentage of lignite varying from 10 to 20.

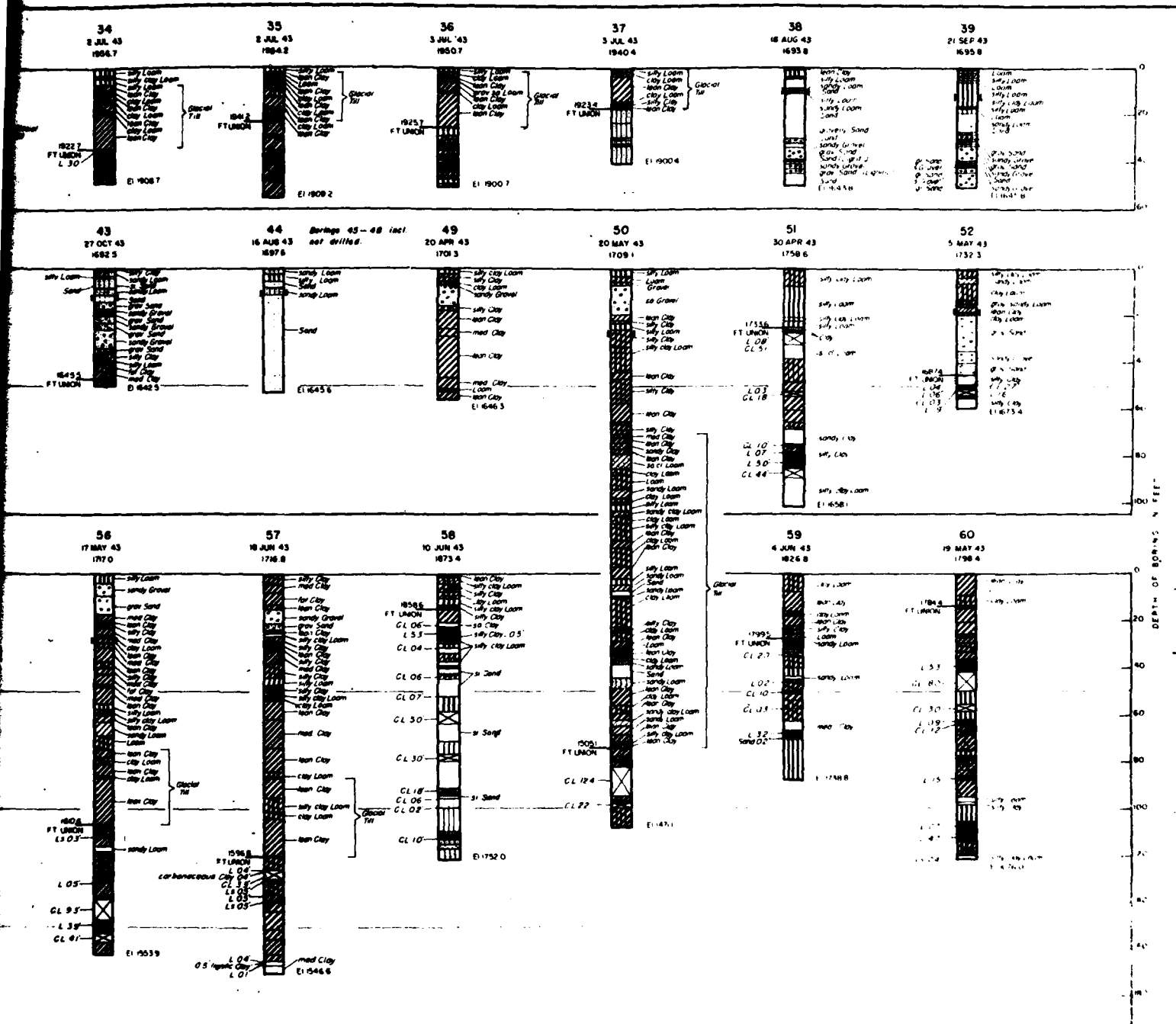
The term lignite does not refer to the percentage of organic material.

For location of bore holes see Drawing No GE3 S/1  
For method of desegregating sections and establishment of  
cross reference system see Drawing No GE3 S/1  
Indicated water table elevations, although derived from  
best available data, should be regarded as approximate  
only and subject to considerable variation  
The following table is to be inspected at the Corps of  
Engineers Office of the district  
Graphic logs give boring information in condensed form  
Further information is shown on the complete boring logs  
which may be inspected at the Corps of Engineers Office  
at the site  
The borings in overburden made by churn type rig  
using 6 inch inside diameter open end drive tube.  
Continuous samples recovered  
All borings in Fort Union made by rotary type rig using  
double tube core barrel. Continuous core 5 1/2 inches  
in diameter recovered  
Complete logs of borings not shown on Record of Borings  
should be inspected at the Corps of Engineers Office  
at the site

**40'R** indicates a hole located 40' feet to right of profile, relative to direction of increase in stationing. Similarly, L stands for left of profile. U, upstream, and D, downstream, are used in instances where R & L are not applicable.







REV	DATE	REVISION (indicated by 1, 2, 3, etc.)

DEPARTMENT OF THE ARMY  
CORPS OF ENGINEERS  
OFFICE OF THE DISTRICT ENGINEER  
BISMARCK, N.D.

MISSOURI RIVER  
**GARRISON DAM AND RESERVOIR**  
**FOUNDATION EXPLORATIONS**  
**RECORD OF BORINGS - 34 TO 60**

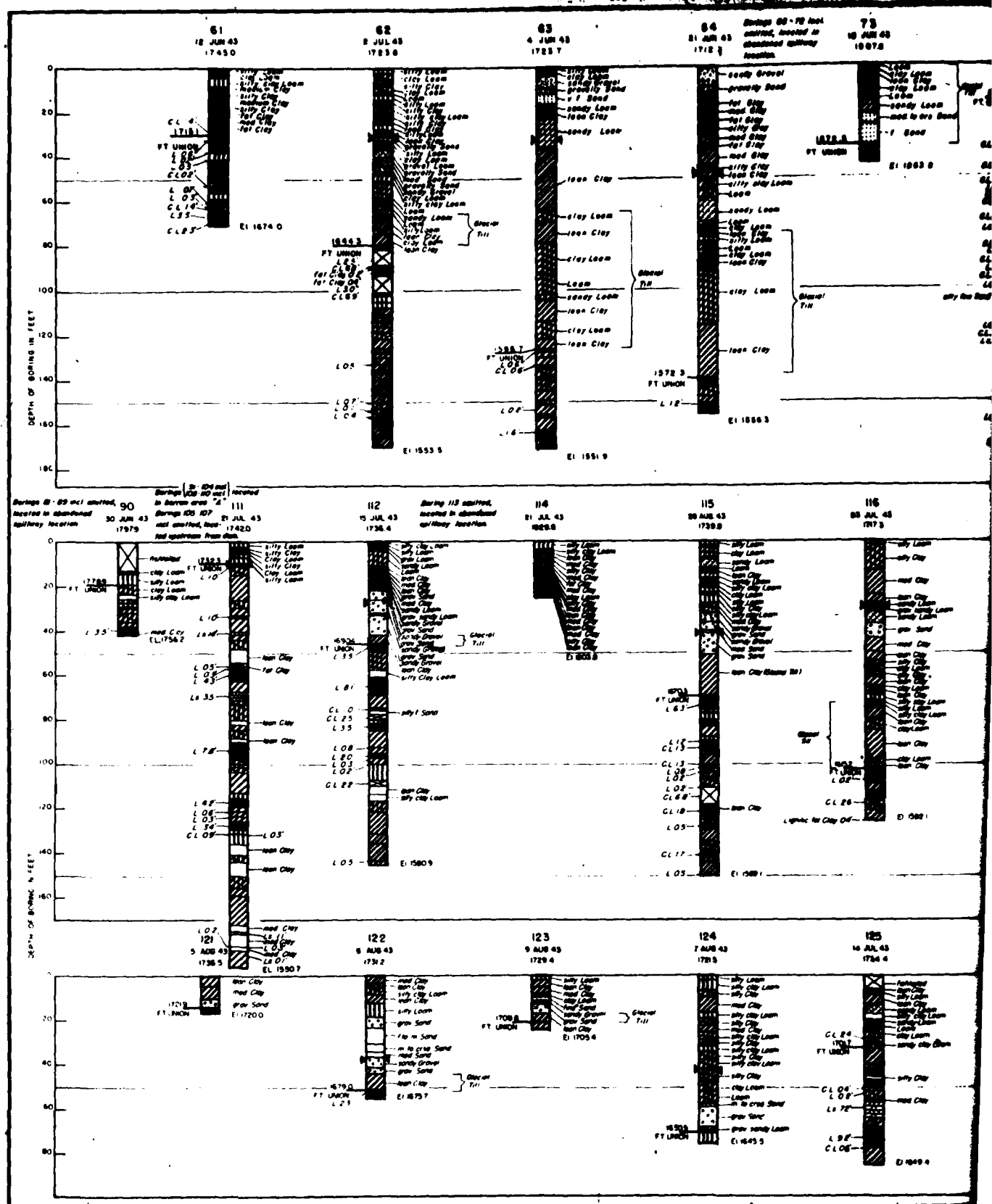
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BY: J.S. Day  
CHECKED: J.S. Day  
APPROVED: J.S. Day

AUGUST 1948

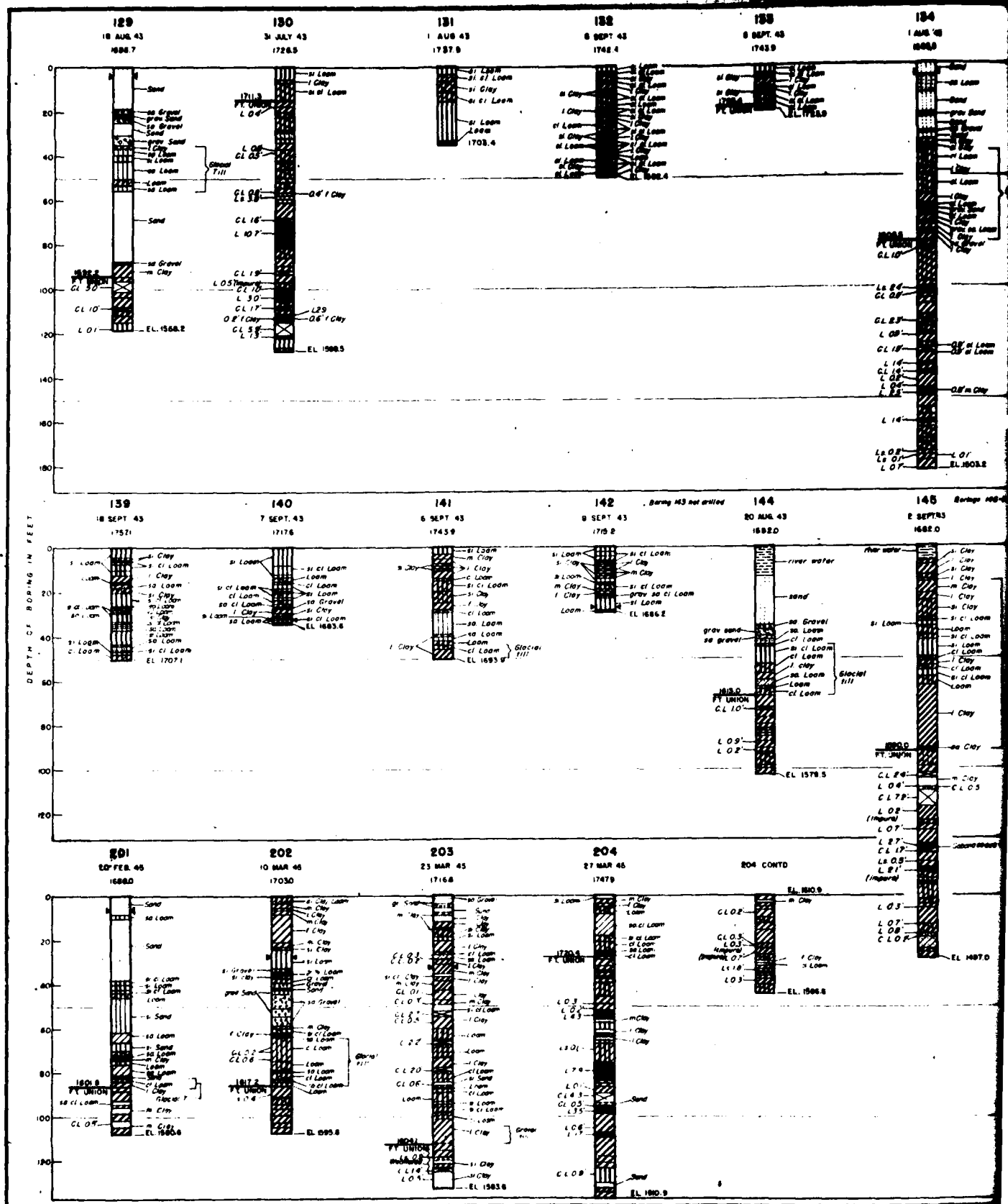
GE3-5/11

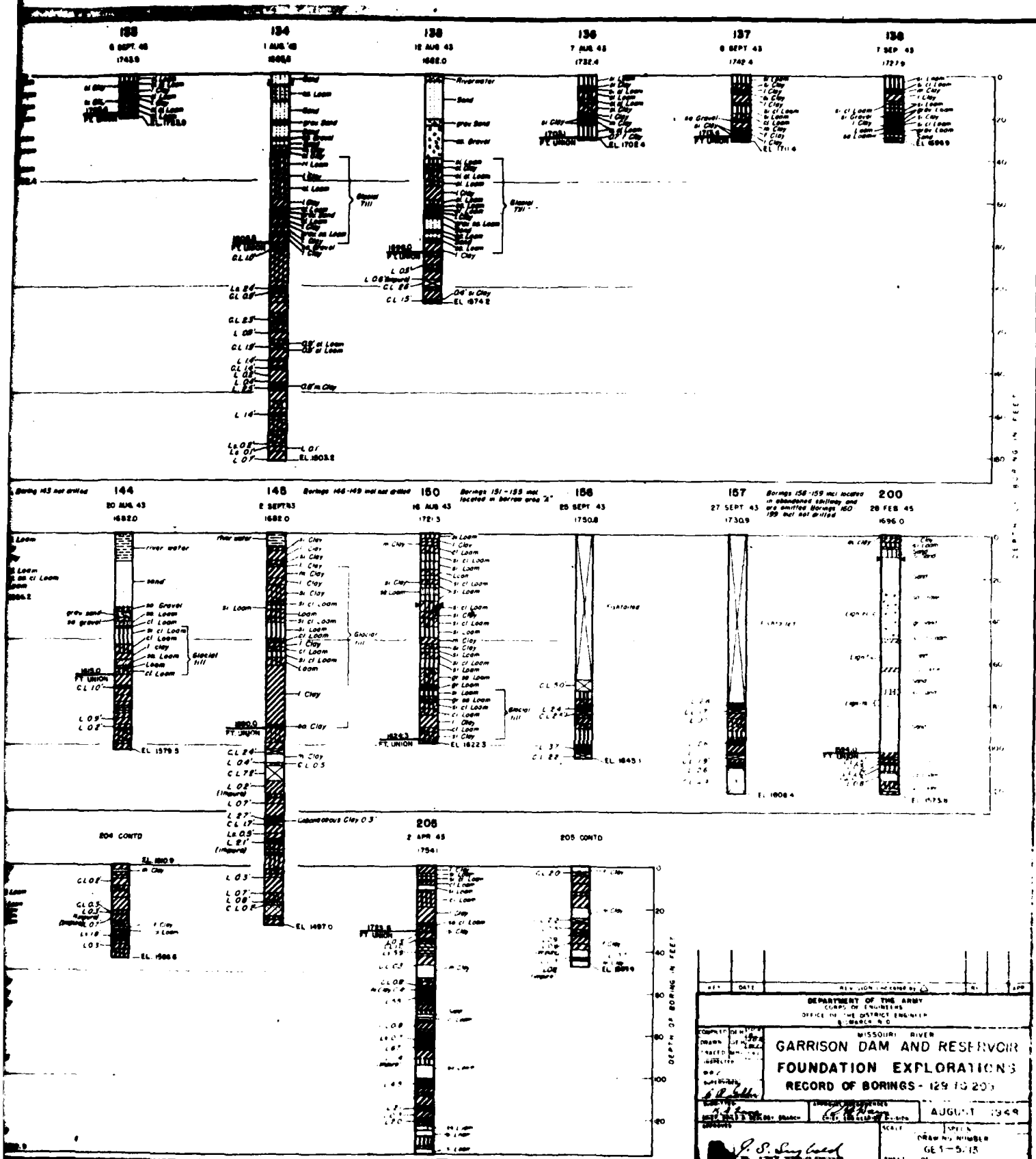
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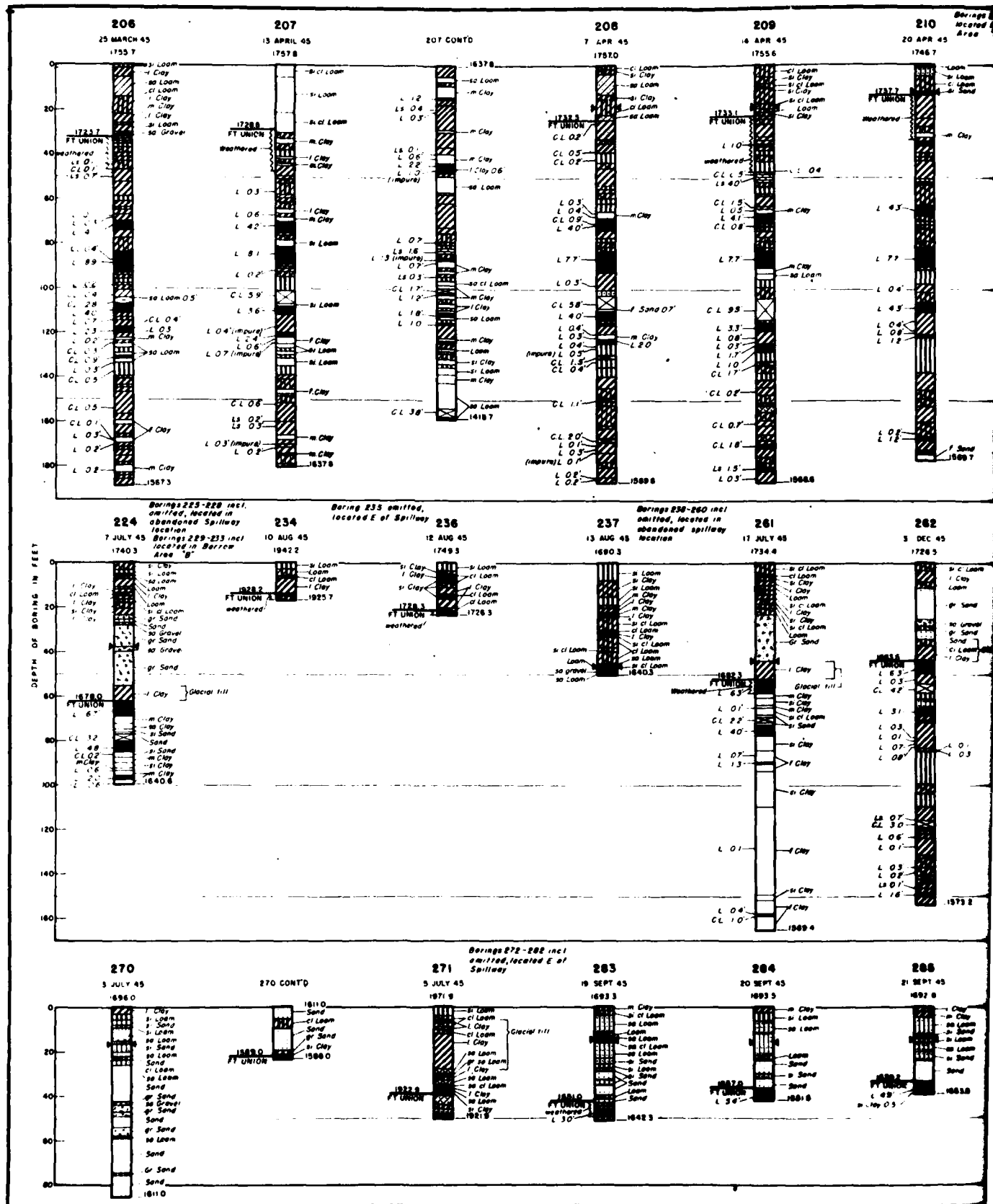




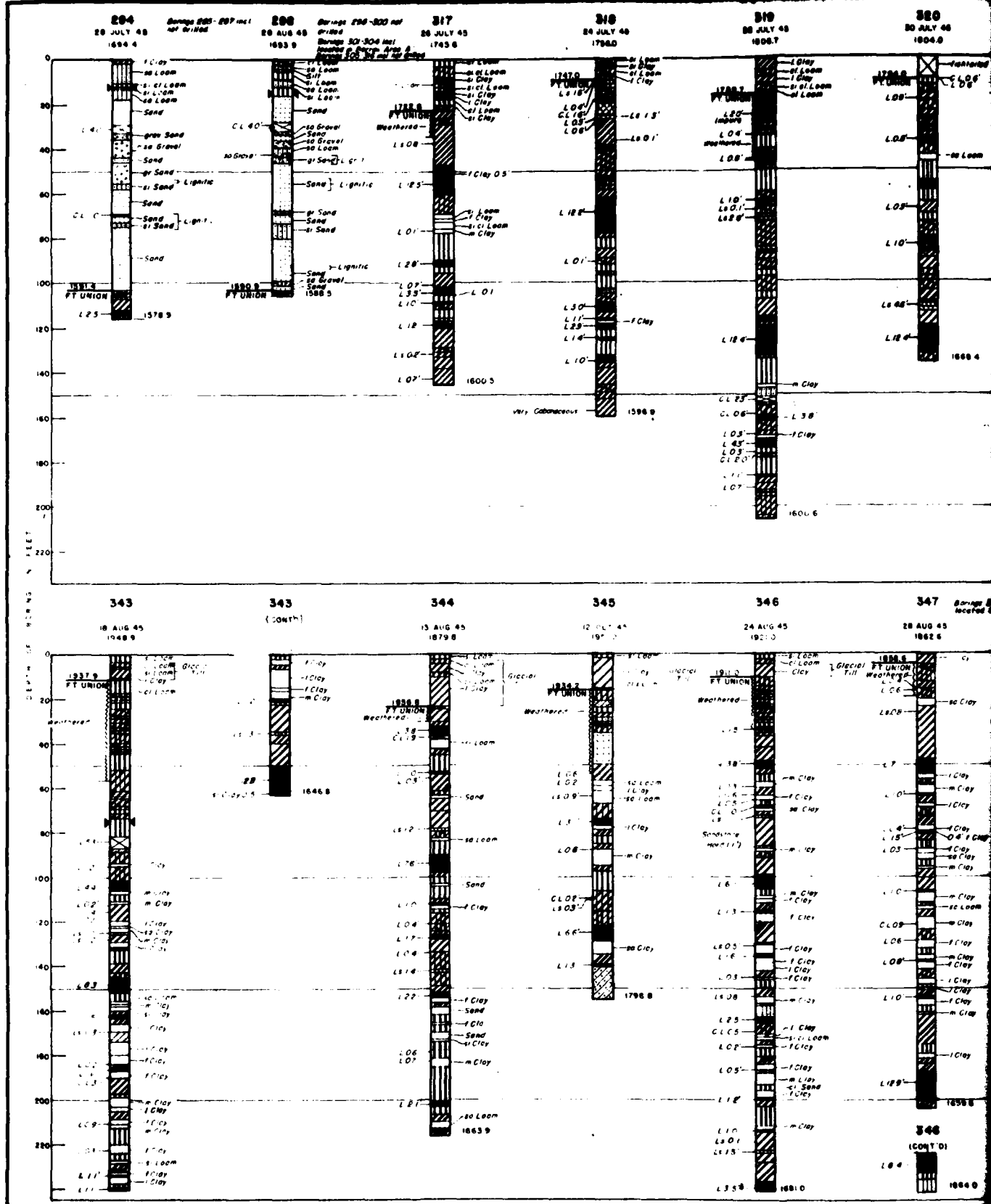


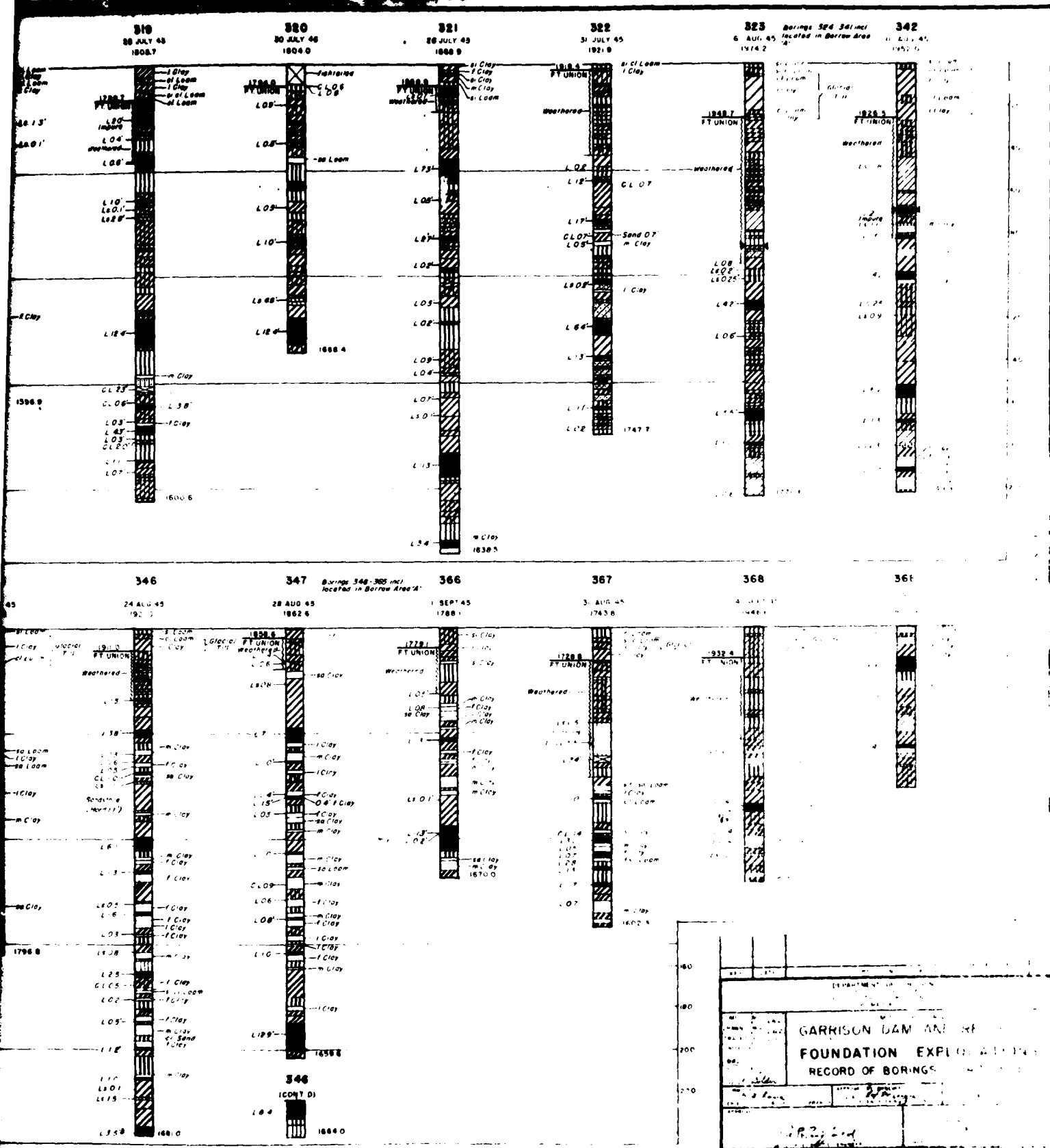






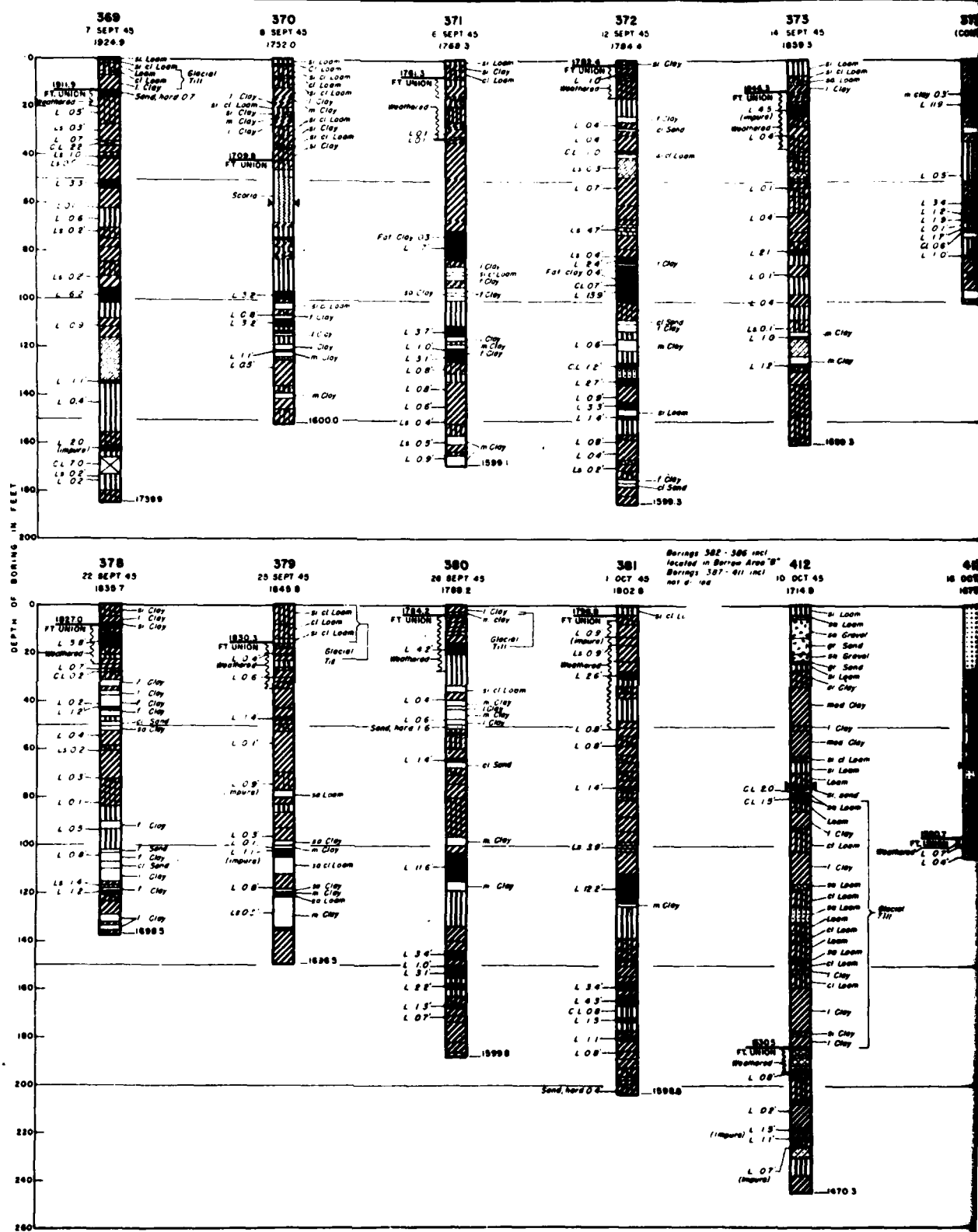


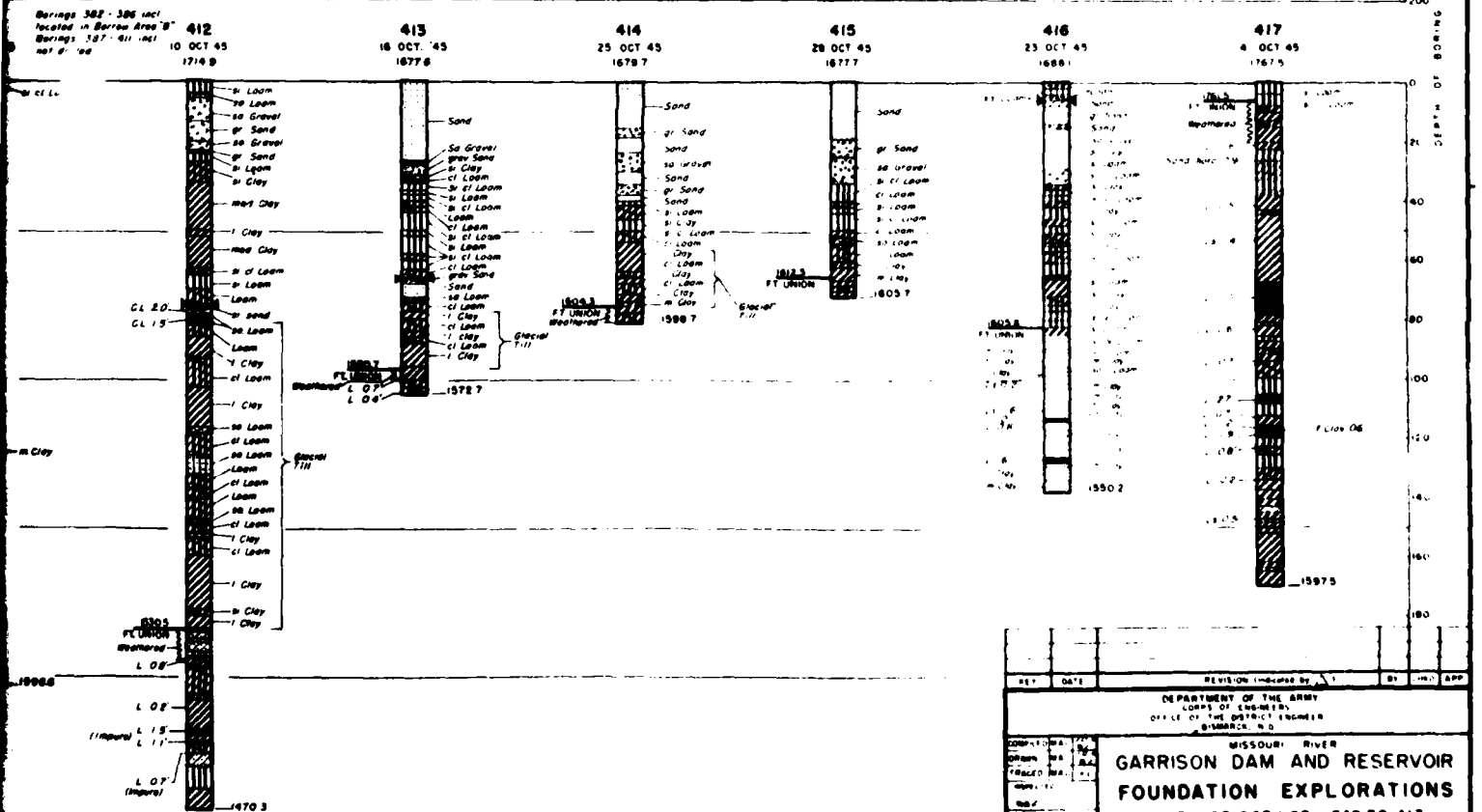
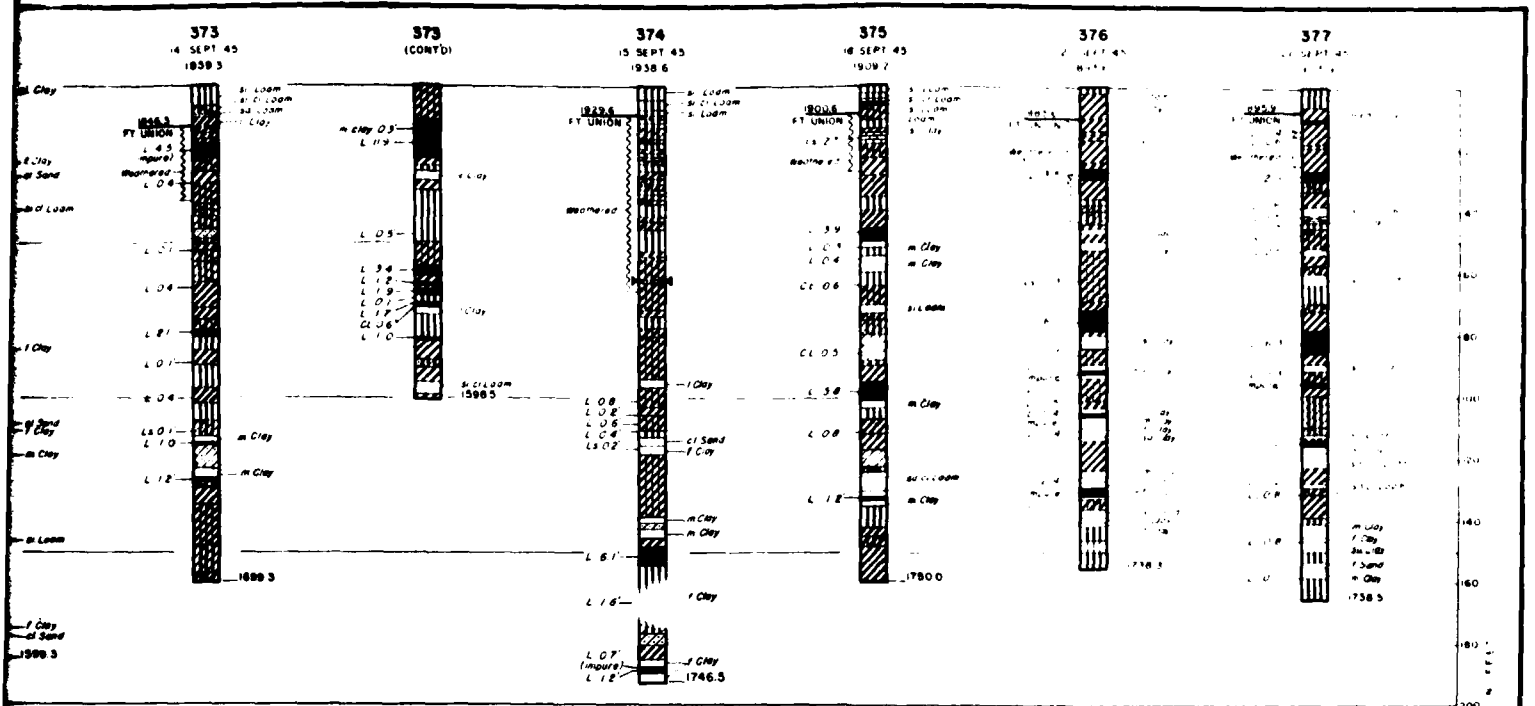




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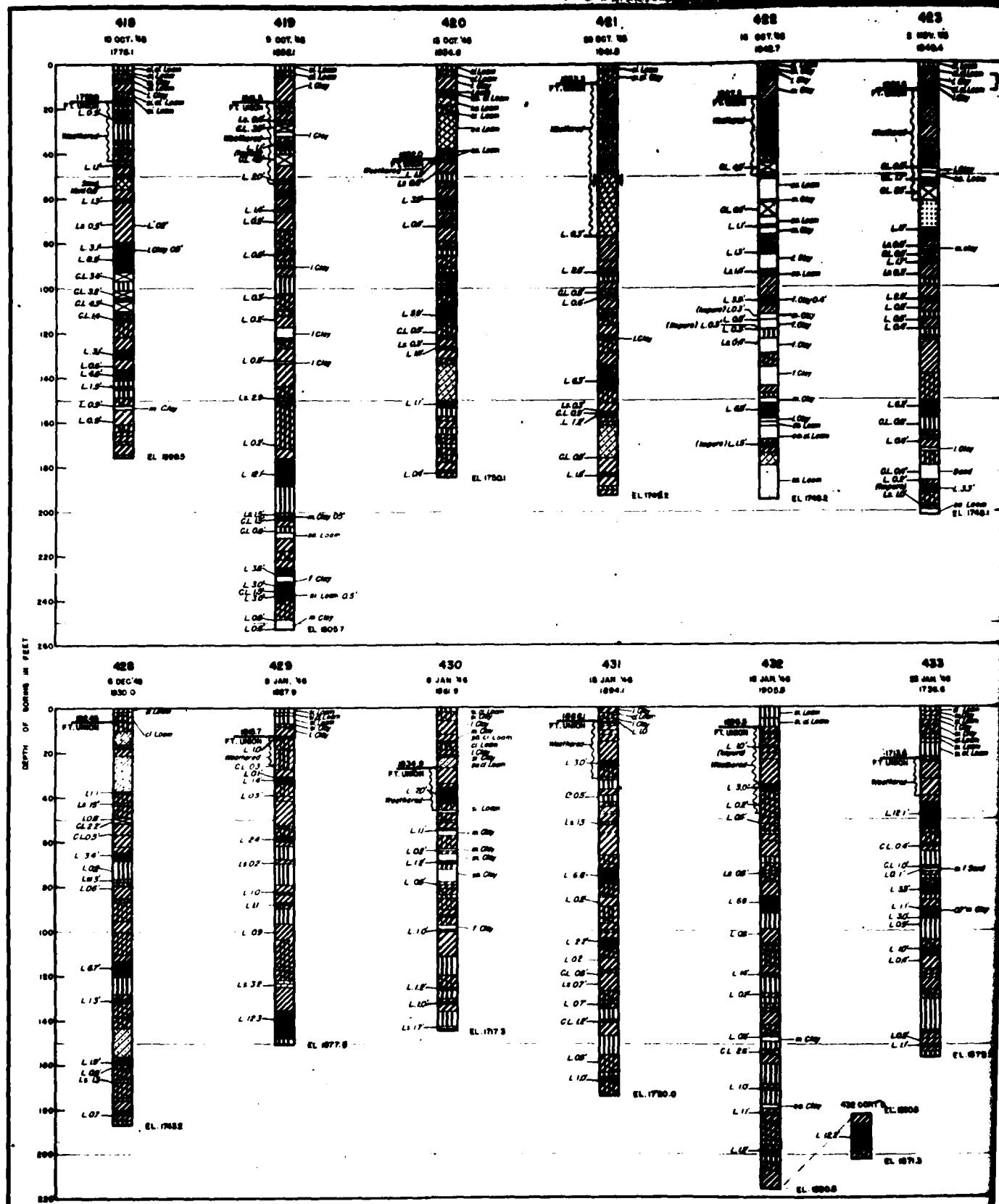


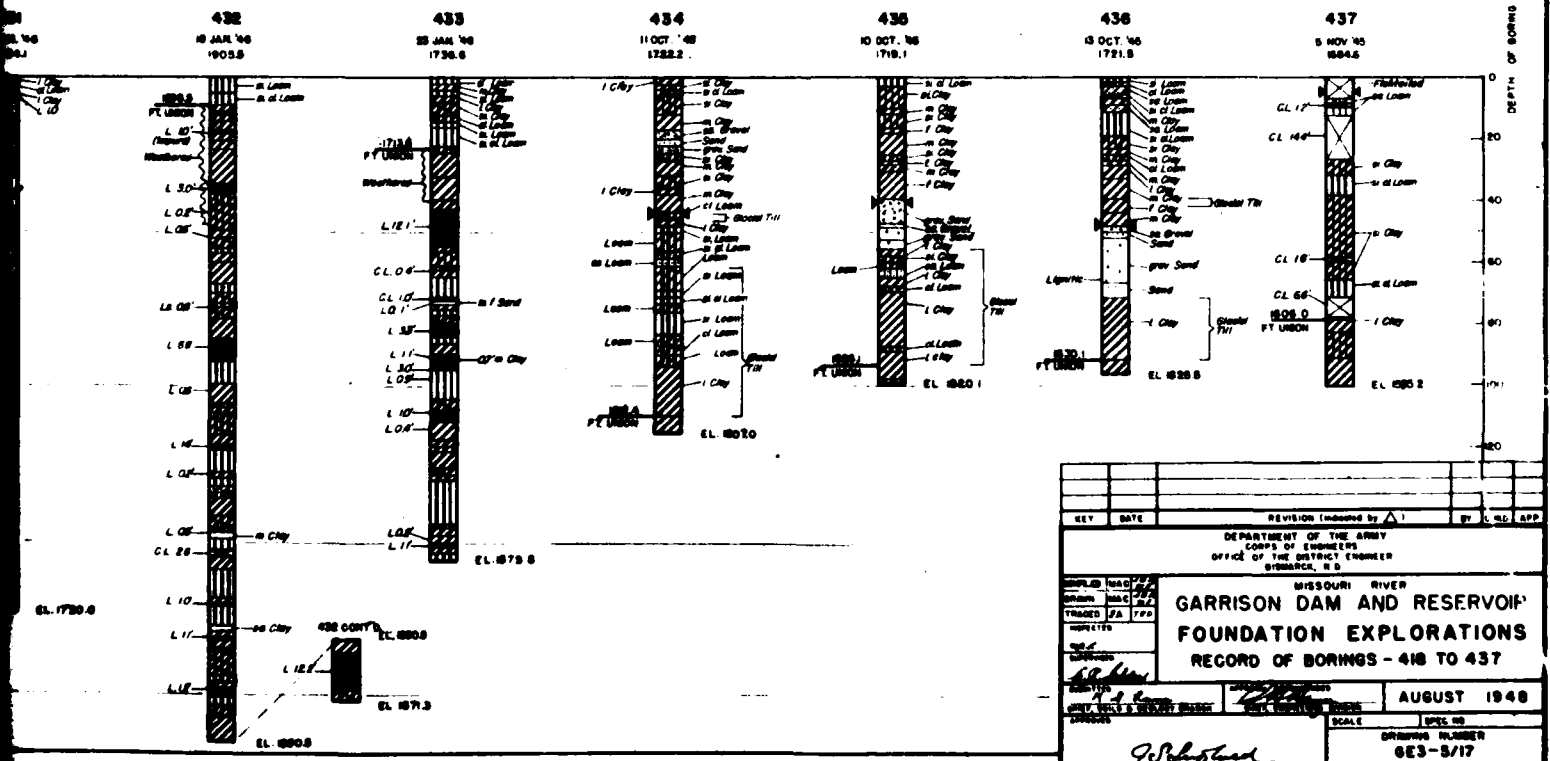
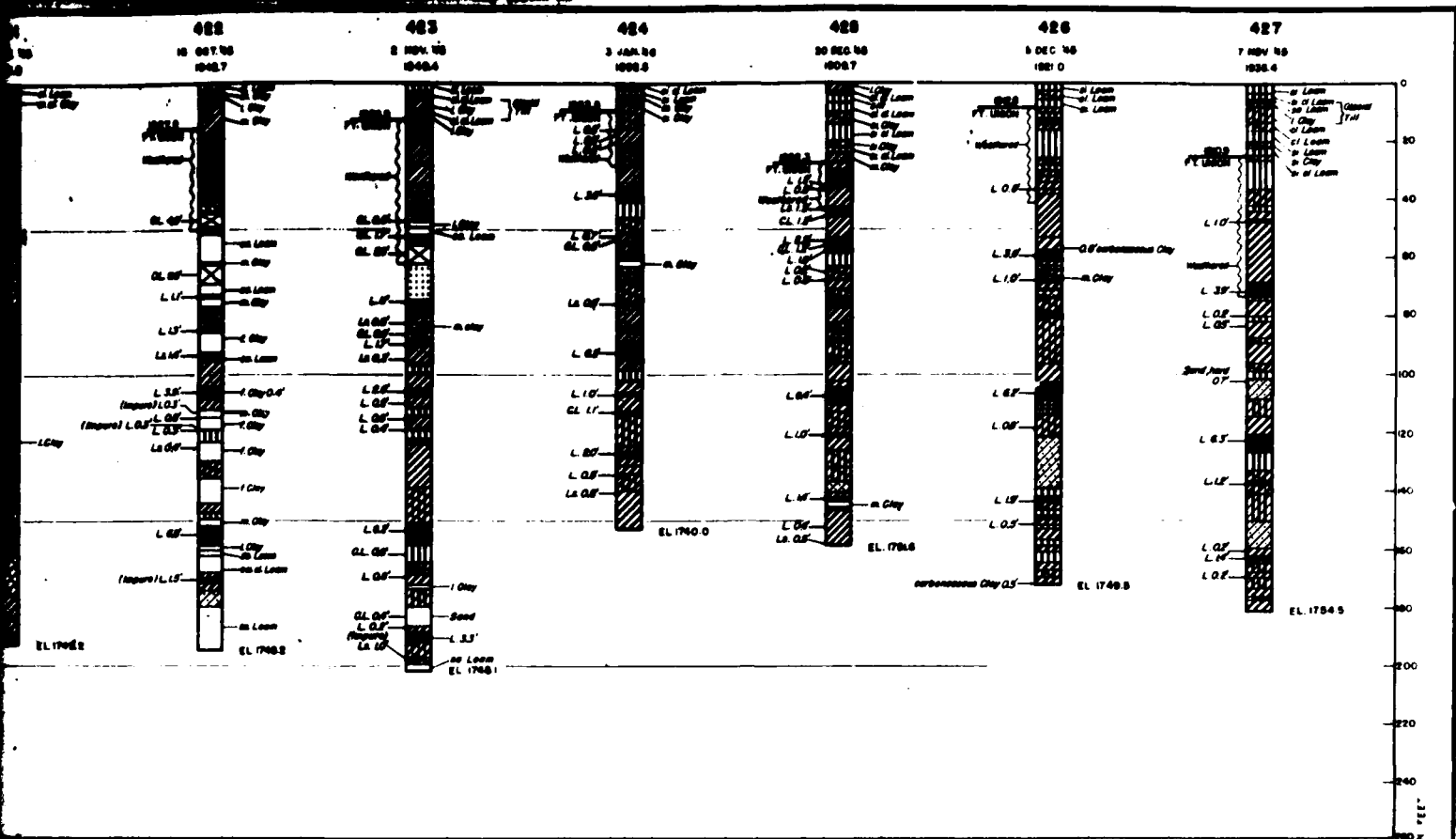




REV.	DATE	REVISION (Indicated by 1, 2, 3, etc.)	BY	APP.
DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DUMMAR, MO.				
MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR</b> <b>FOUNDATION EXPLORATIONS</b> <b>RECORD OF BORINGS - 369 TO 417</b>				
COMPILED BY	DATE	REVISION (Indicated by 1, 2, 3, etc.)	BY	APP.
TRACED BY	DATE	REVISION (Indicated by 1, 2, 3, etc.)	BY	APP.
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DRAWN BY G. S. - 5/16		SCALE 1" = 10'		

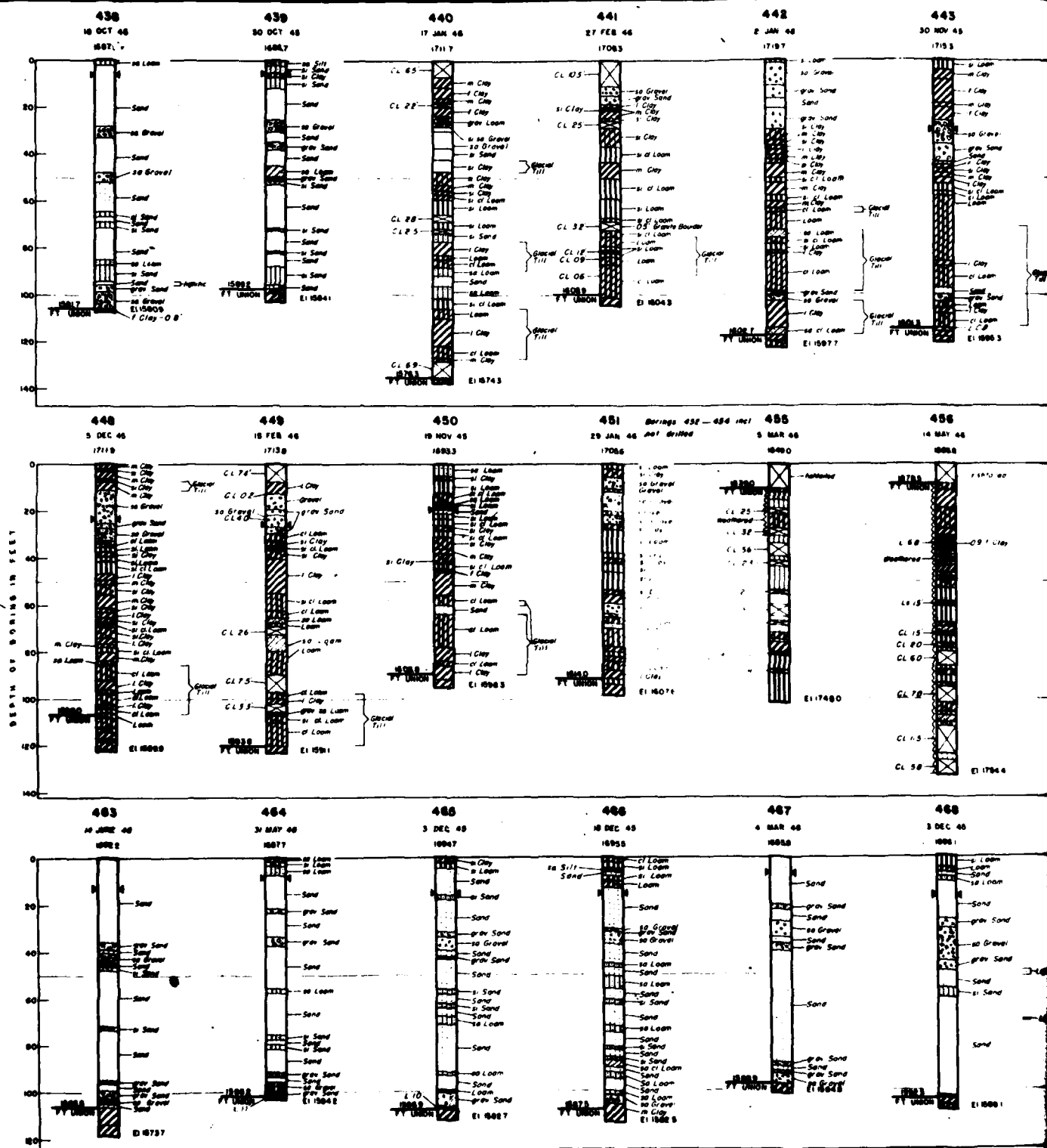
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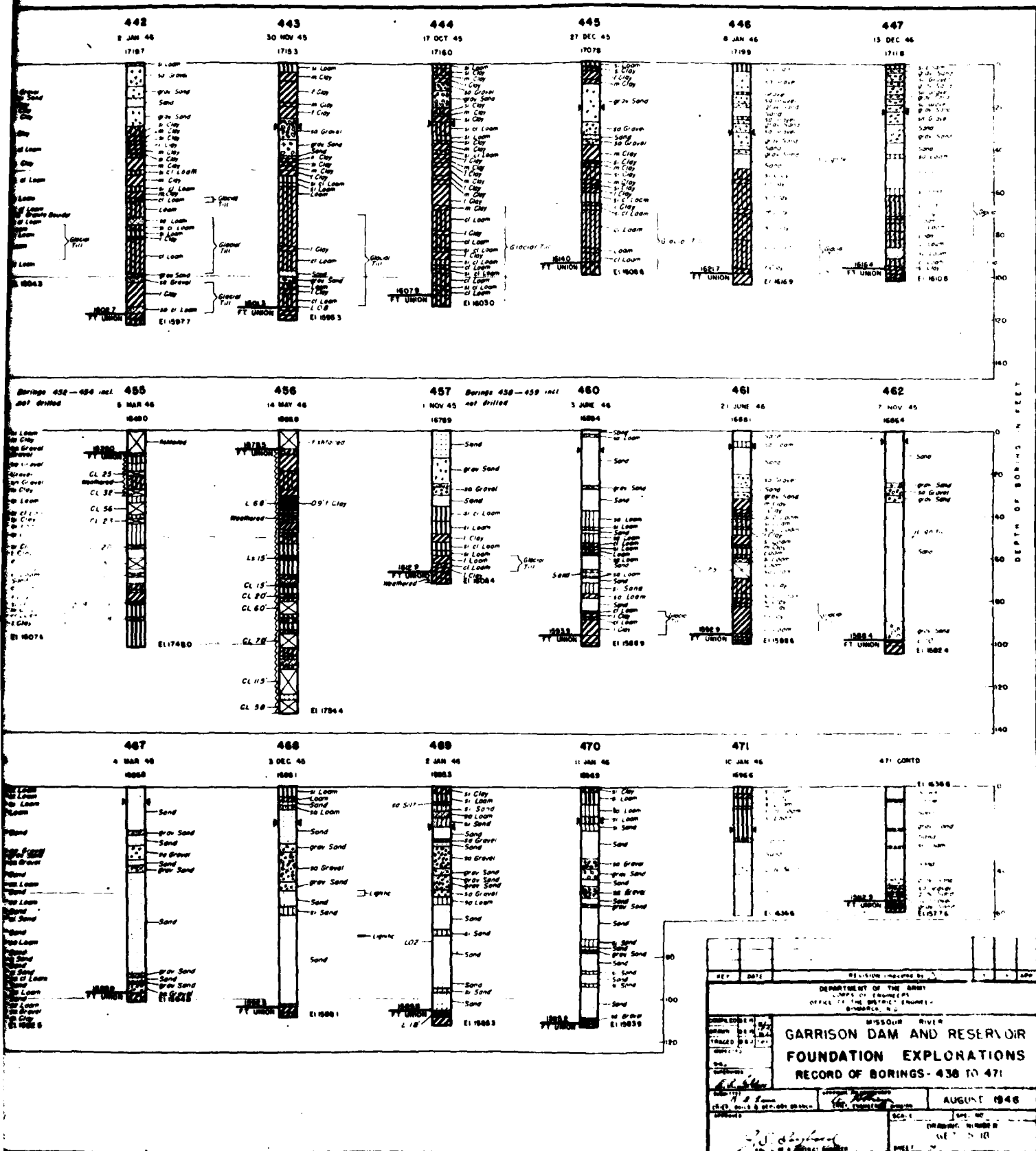


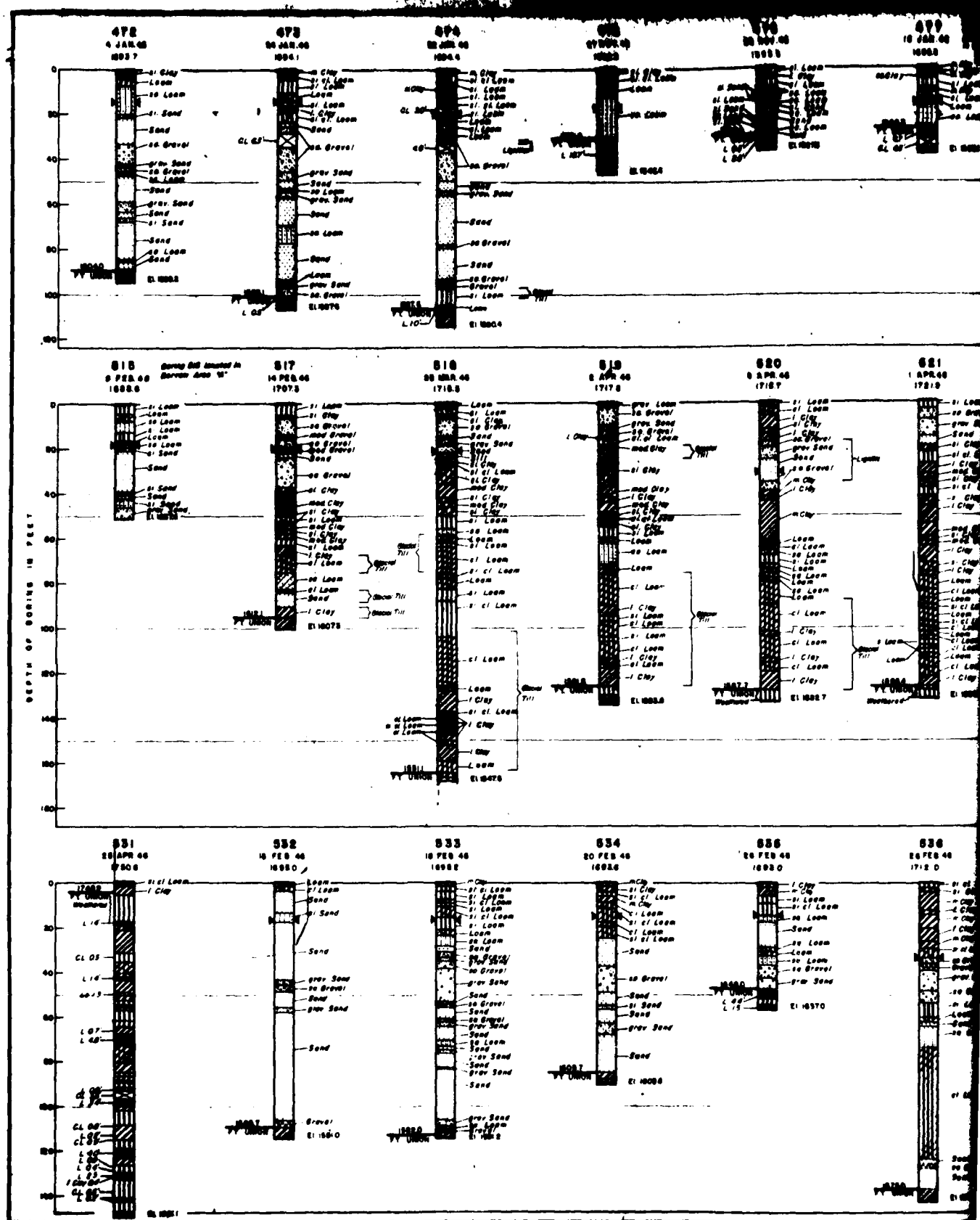


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DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.					
MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR</b> <b>FOUNDATION EXPLORATIONS</b> <b>RECORD OF BORINGS - 418 TO 437</b>					
SAMPLED TESTED ANALYZED CORRECTED	NAME GRADE POSITION	DATE TIME PLACE	SCALE SHEET NO.	AUGUST 1948 623-5/17	

2

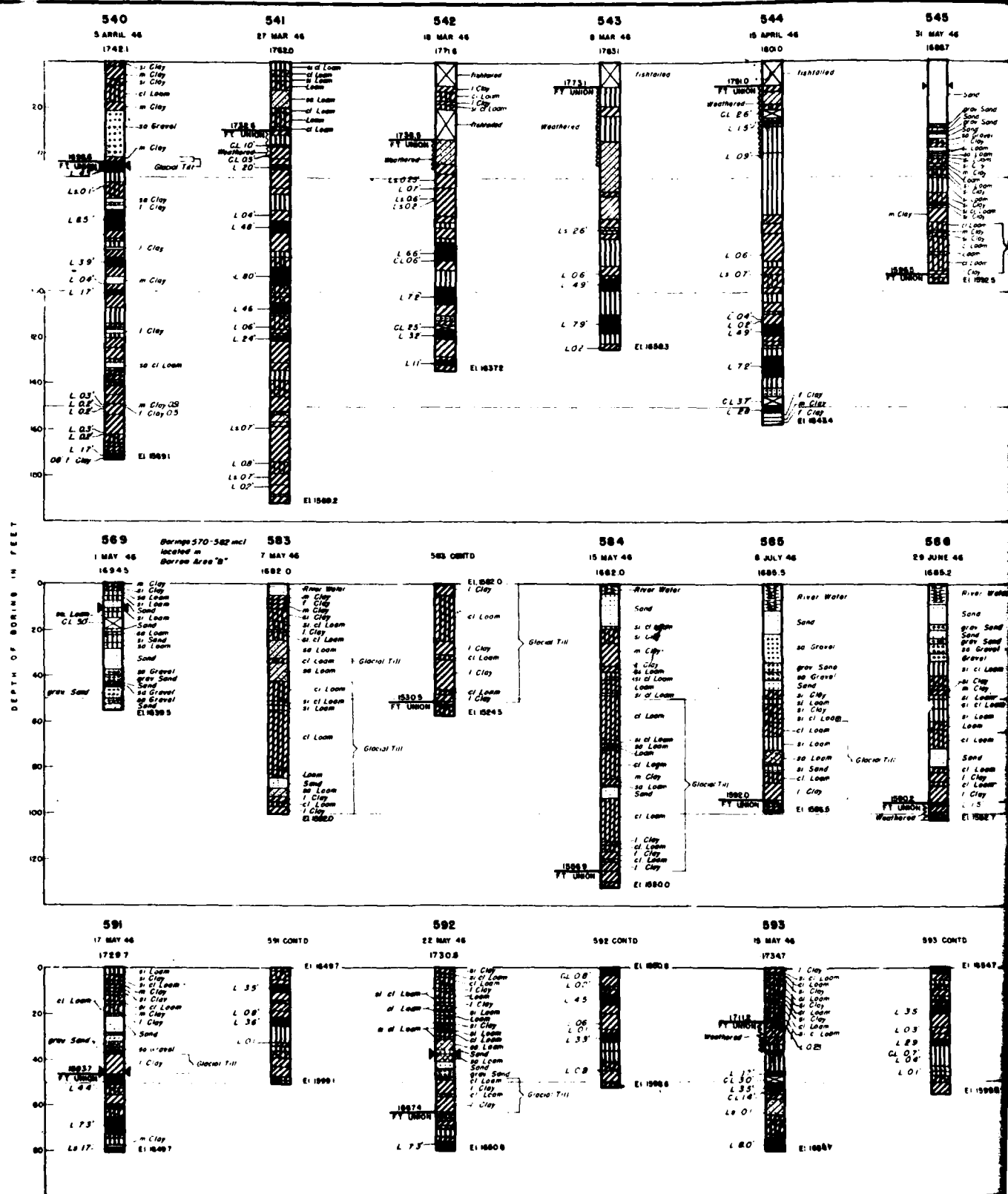




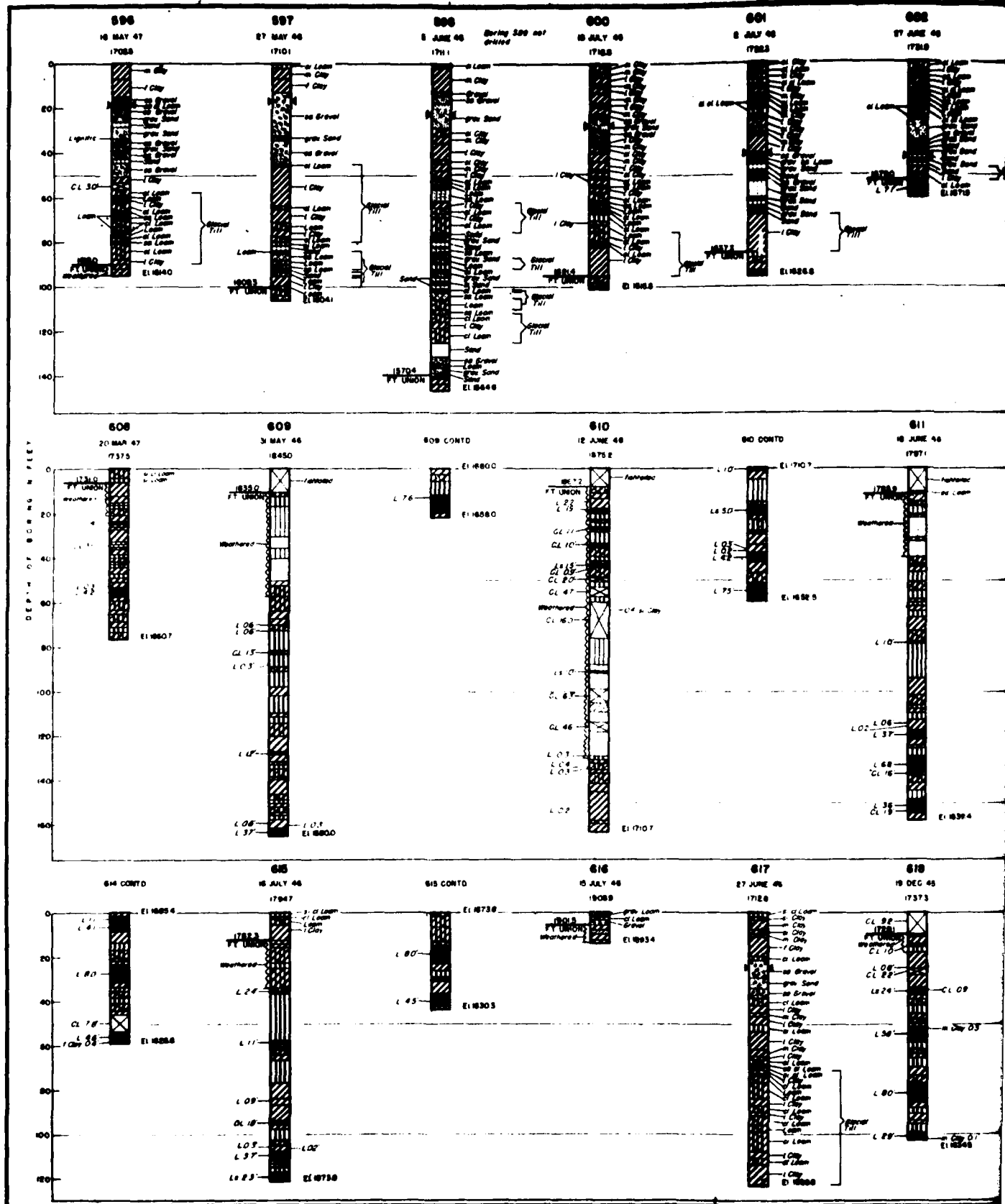


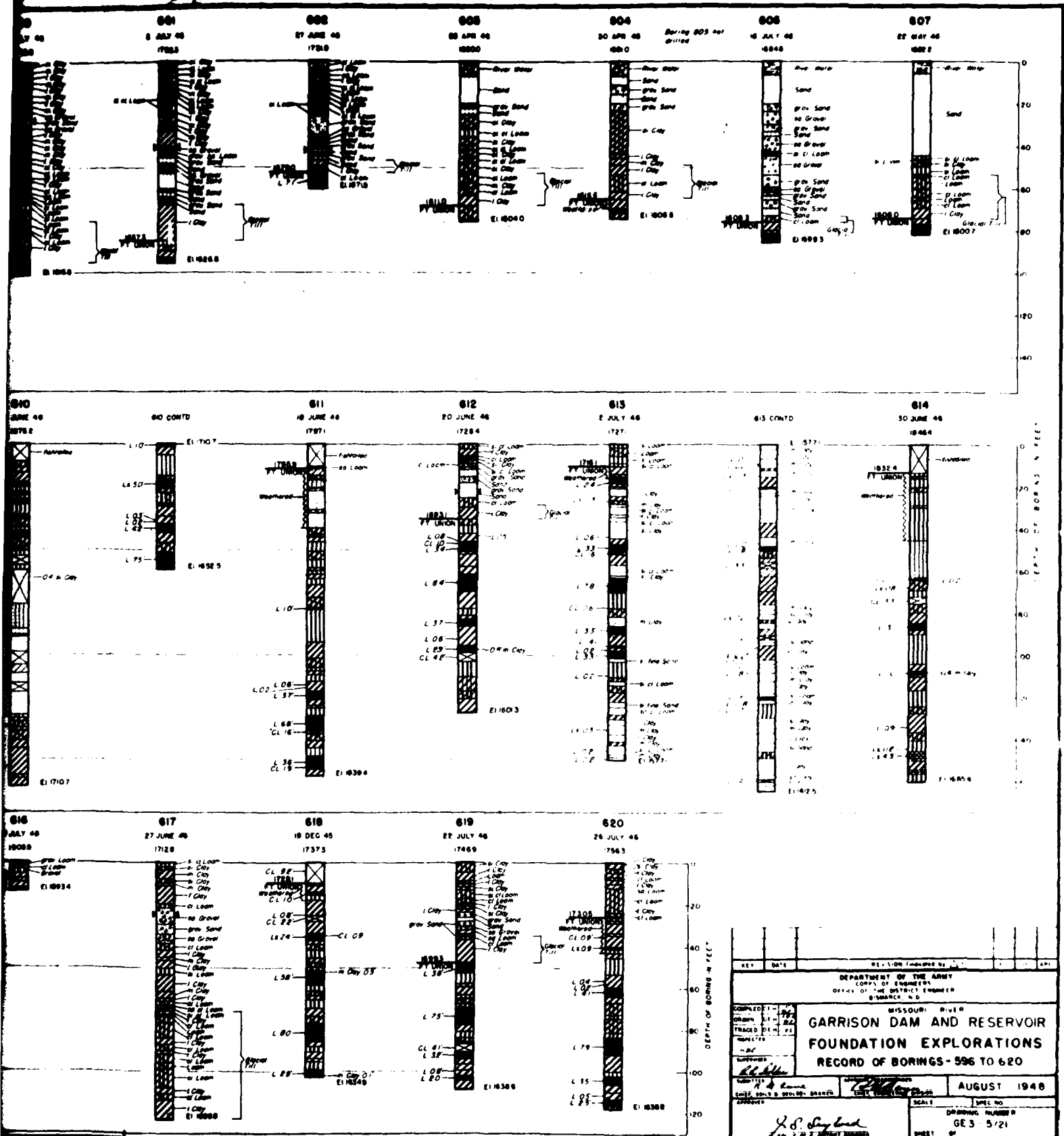


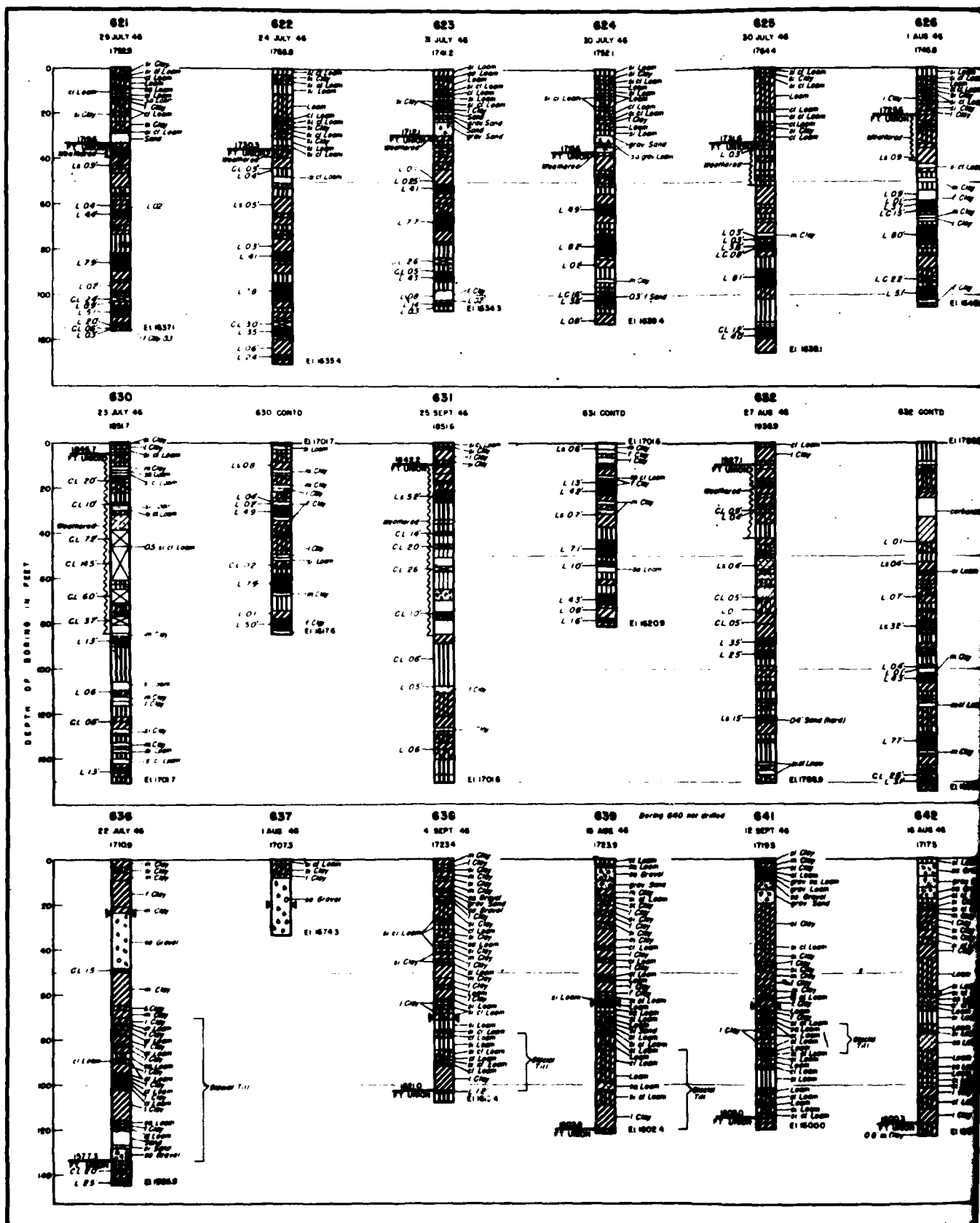


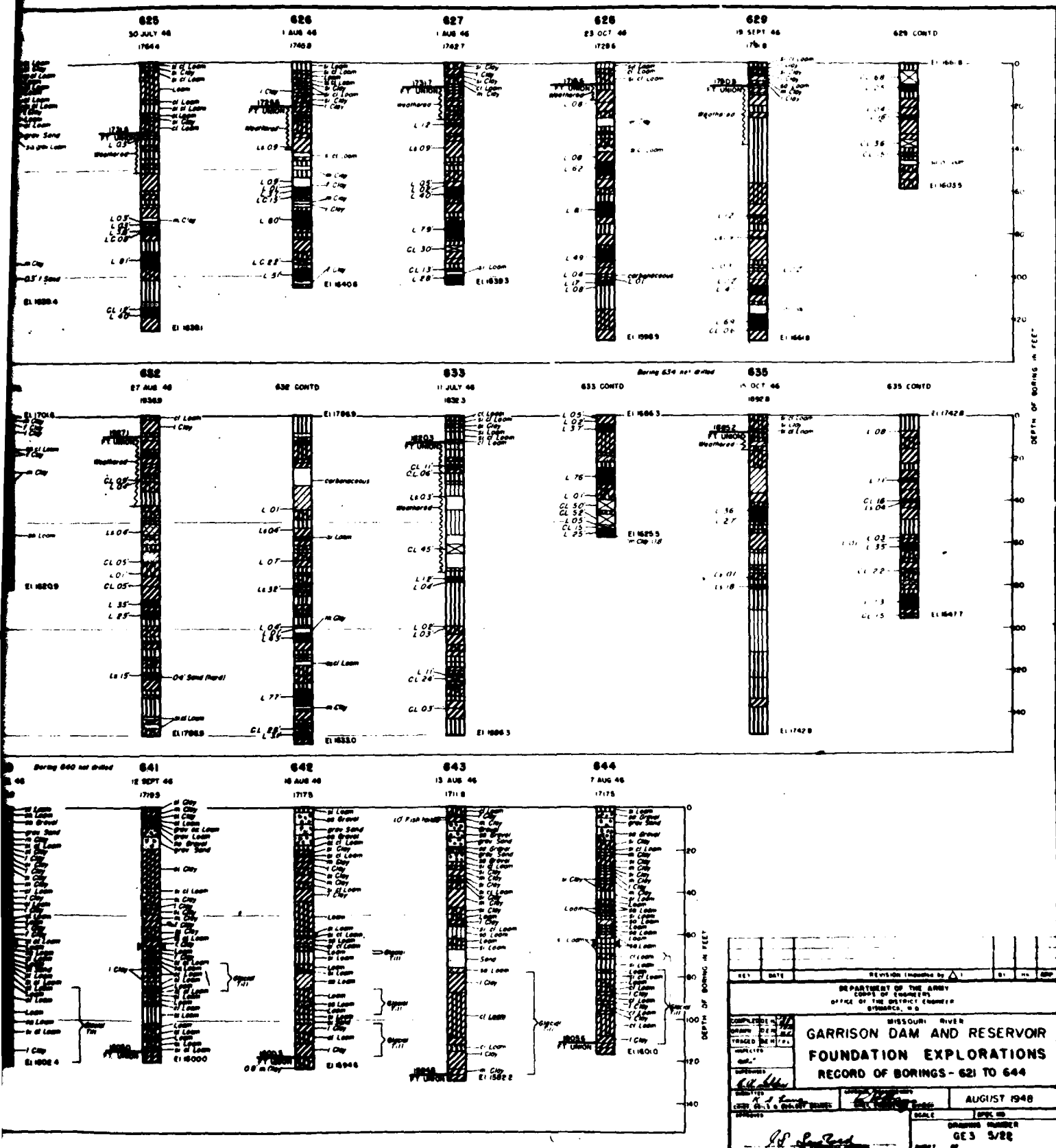




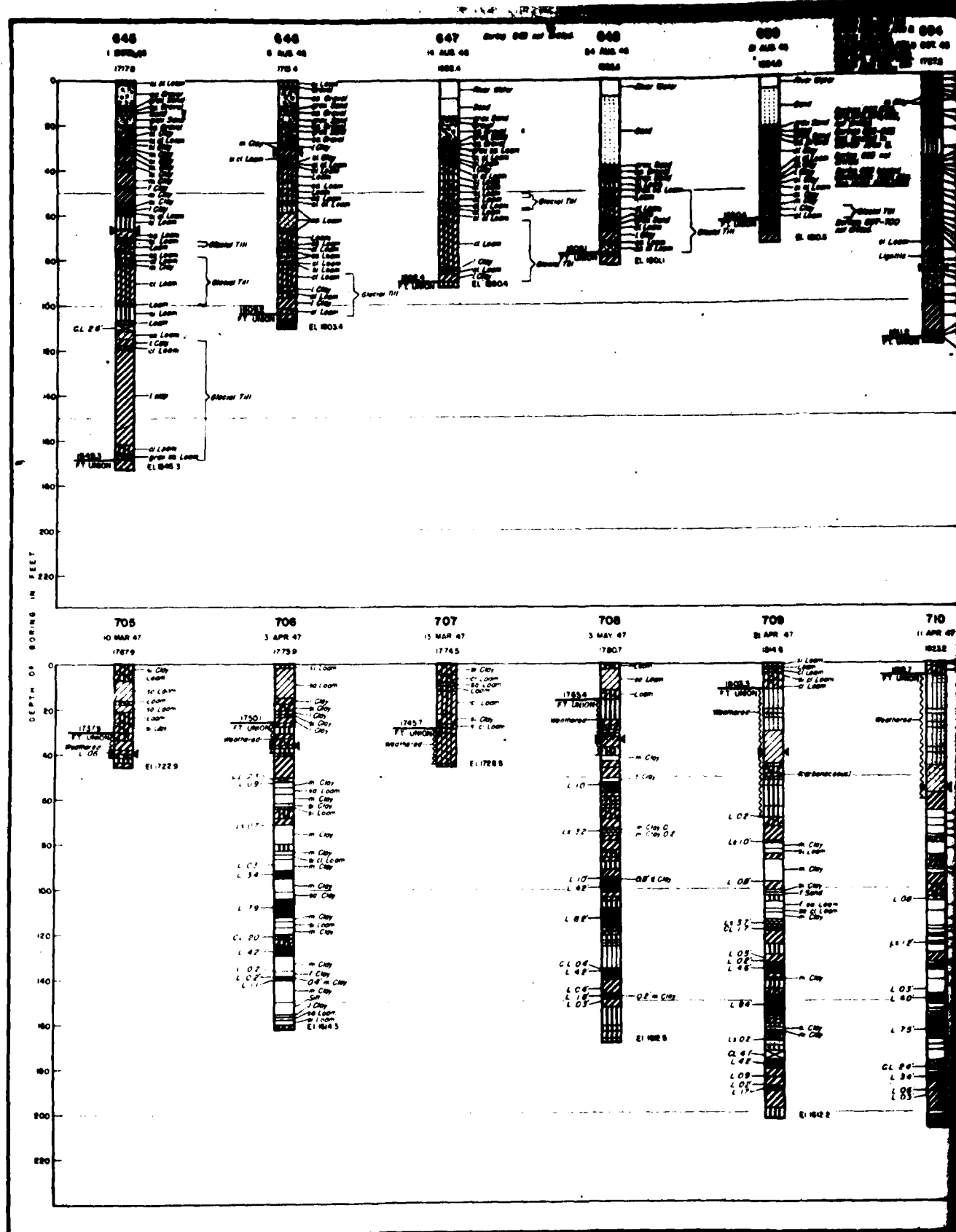






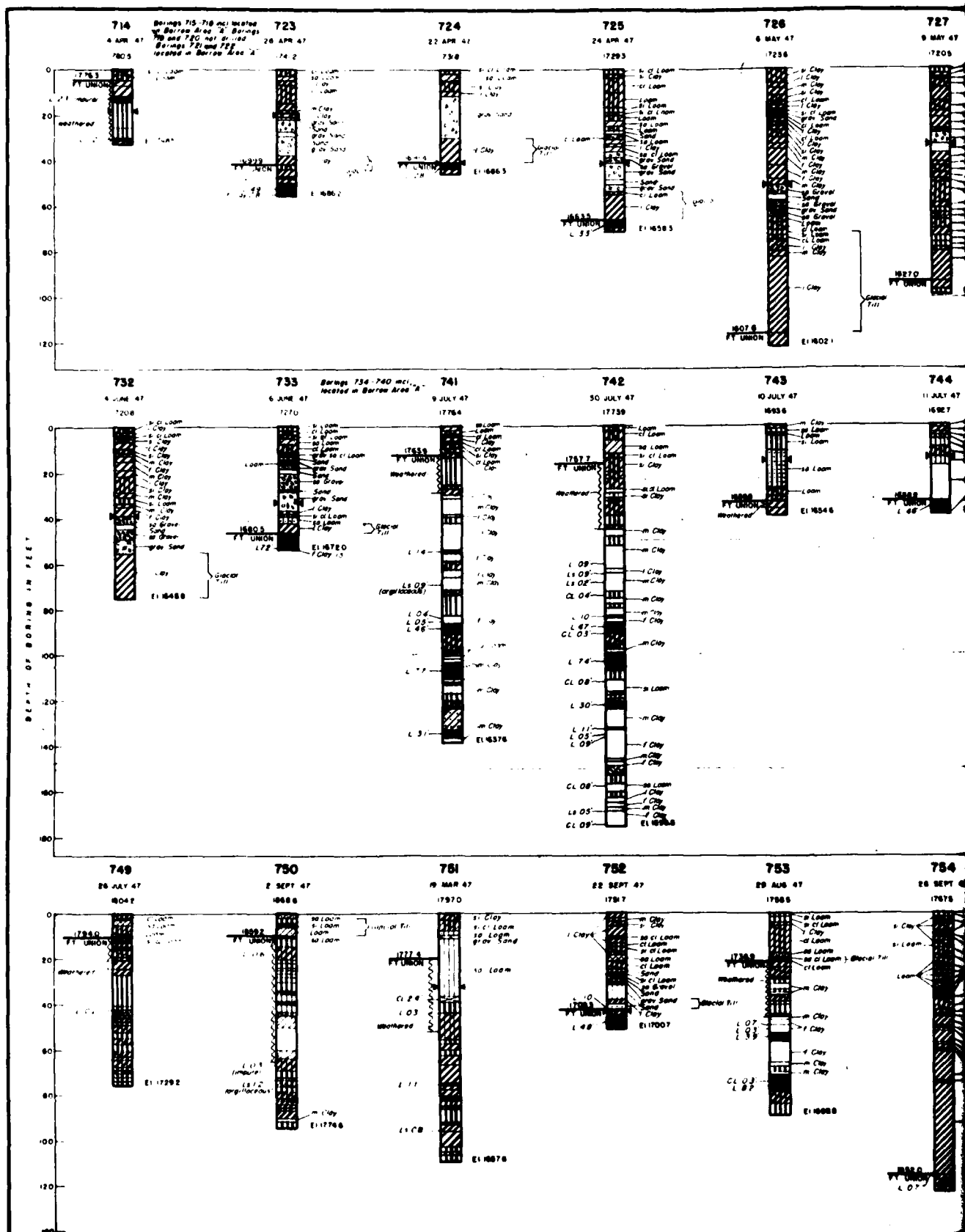


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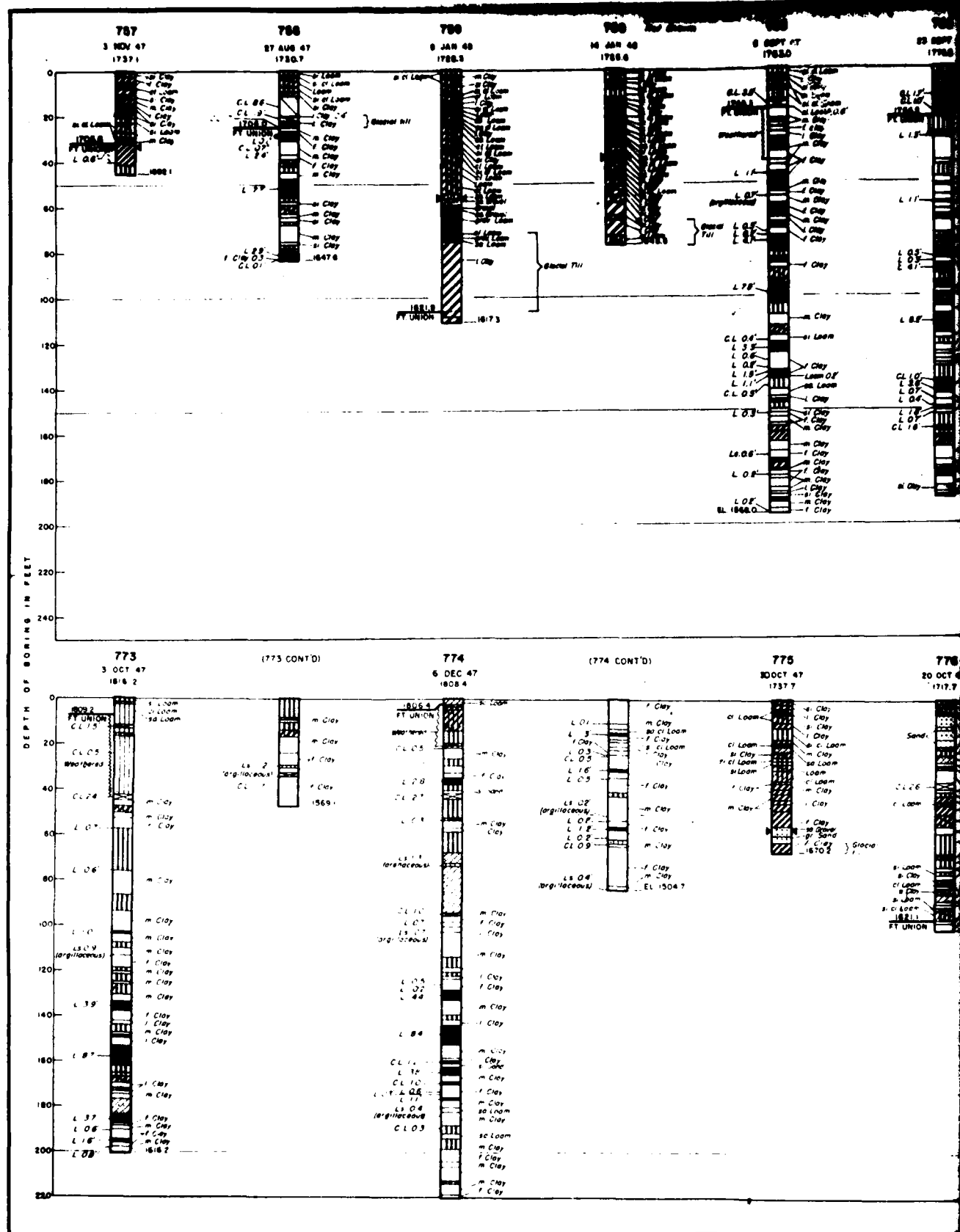






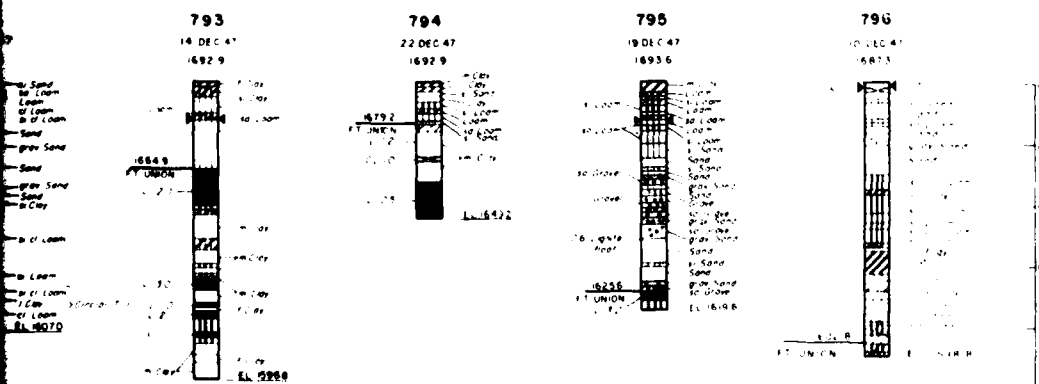
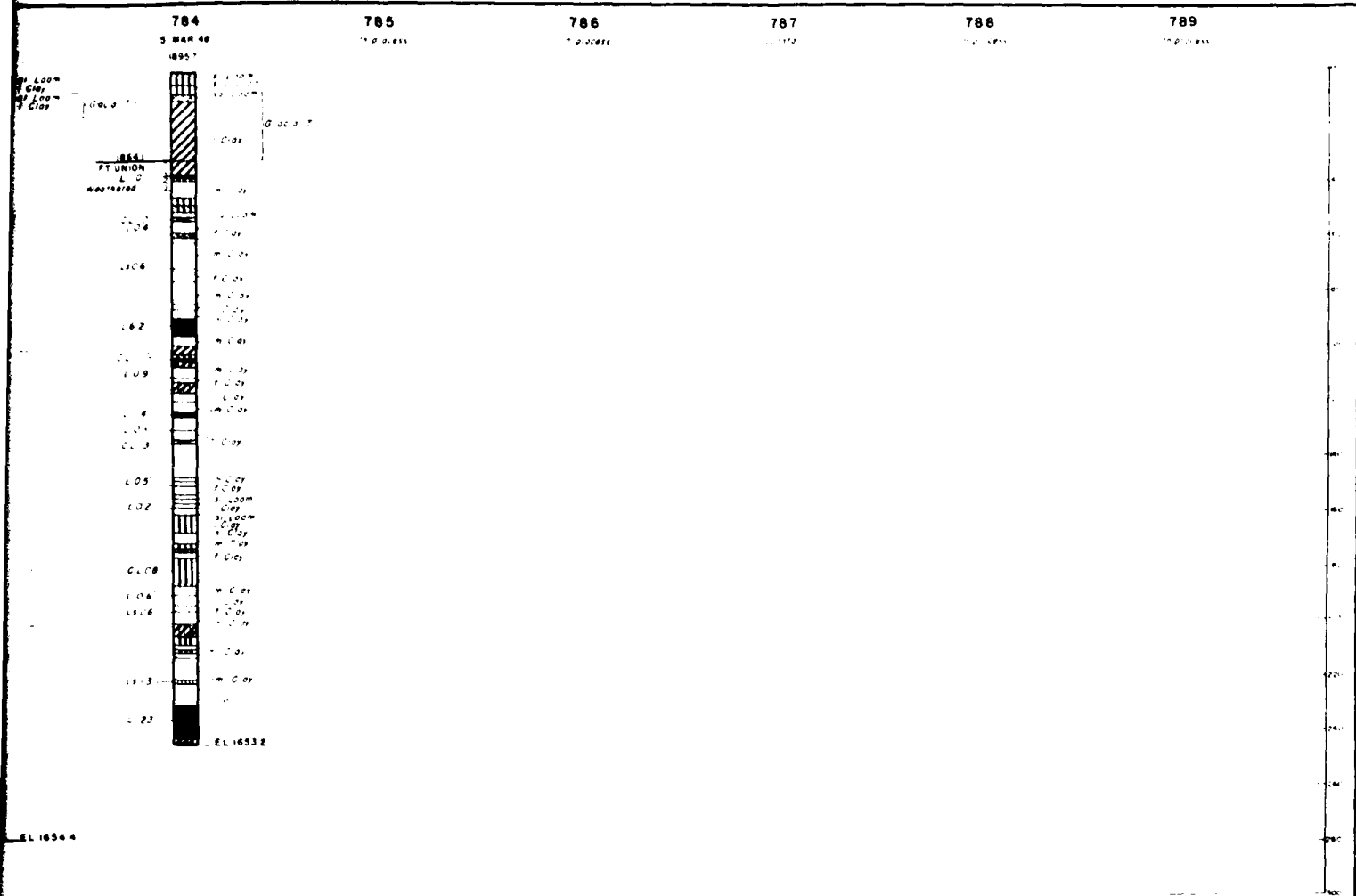




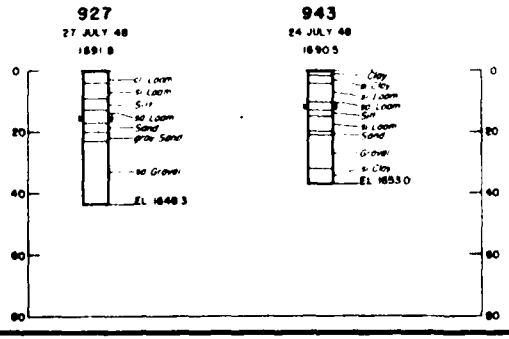
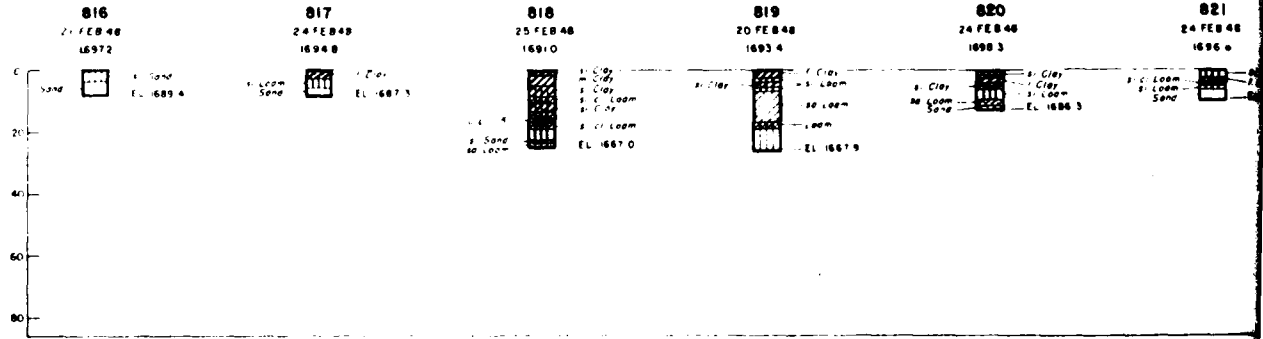
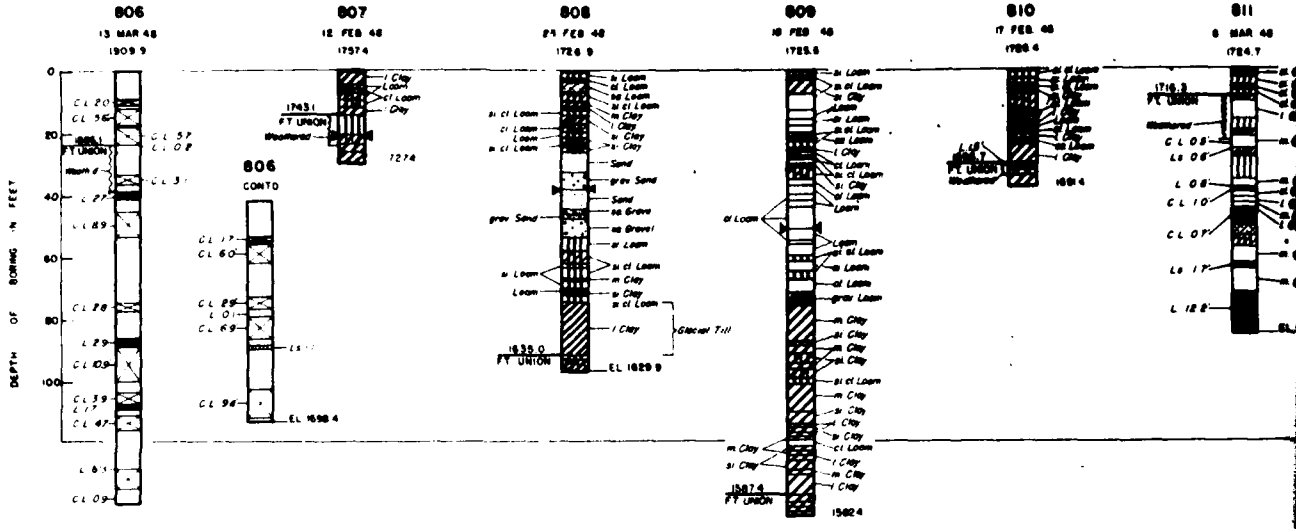
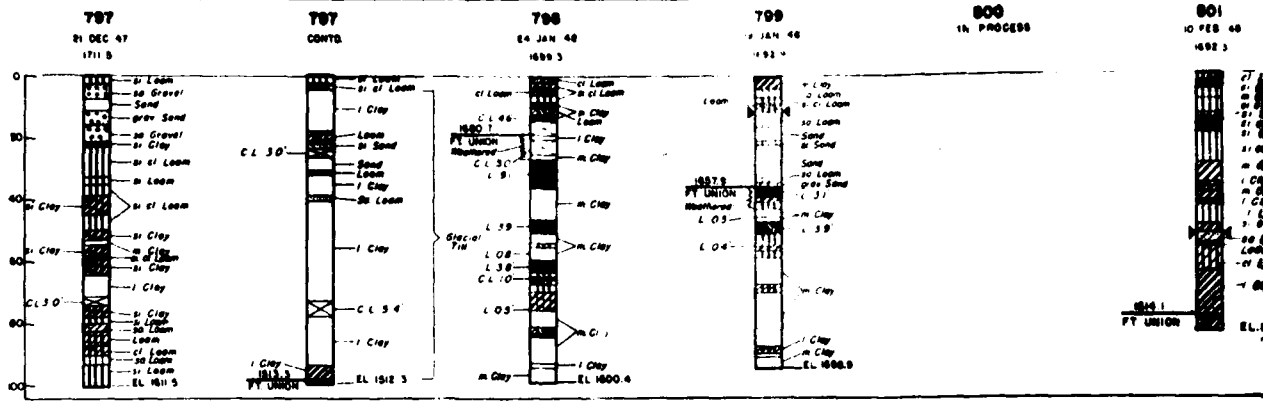




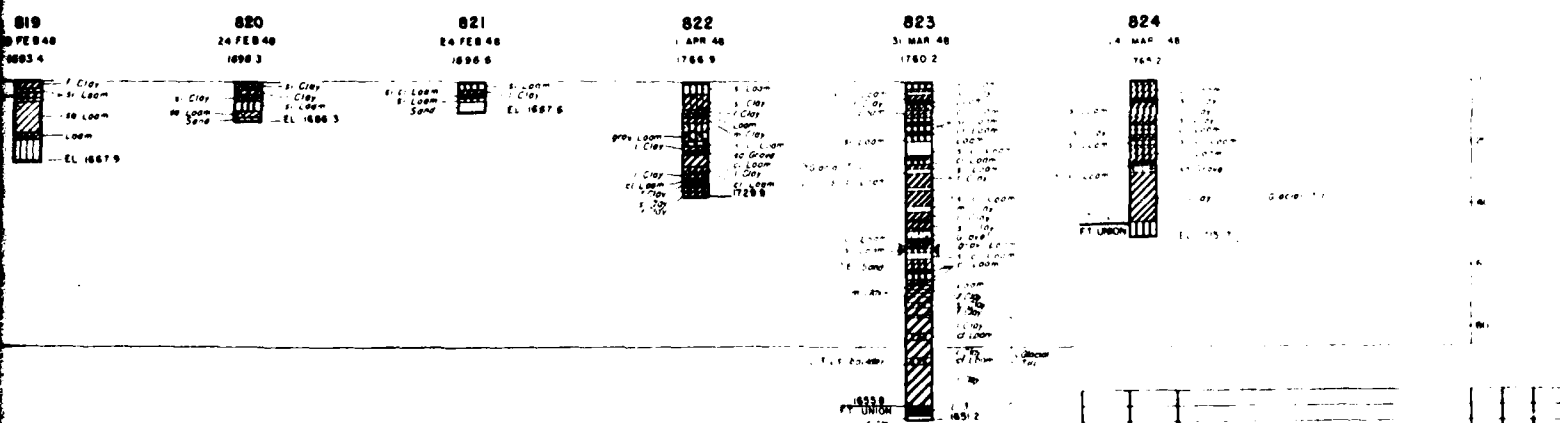




REVISIONS		REVISIONS	
NO.	DATE	BY	REASON
DEPARTMENT OF THE ARMY OFFICE OF THE DISTRICT ENGINEER BIRMINGHAM, ALA.			
MISSISSIPPI RIVER <b>GARRISON DAM AND RESERVOIR</b> <b>FOUNDATION EXPLORATIONS</b> <b>RECORD OF BORINGS 780 TO 796</b>			
DRAWN BY CHECKED BY DATE SCALE SHEET NO.	SUBMITTED BY DATE SCALE SHEET NO.	APPROVED BY DATE SCALE SHEET NO.	AUGUST 1948 DRAWING NUMBER GE 3 5 20 SHEET NO.



**NOTES**  
 Borings not shown indicate  
 boring not made or not in area of contract.  
 See General Notes See Drawing of 9-5-10

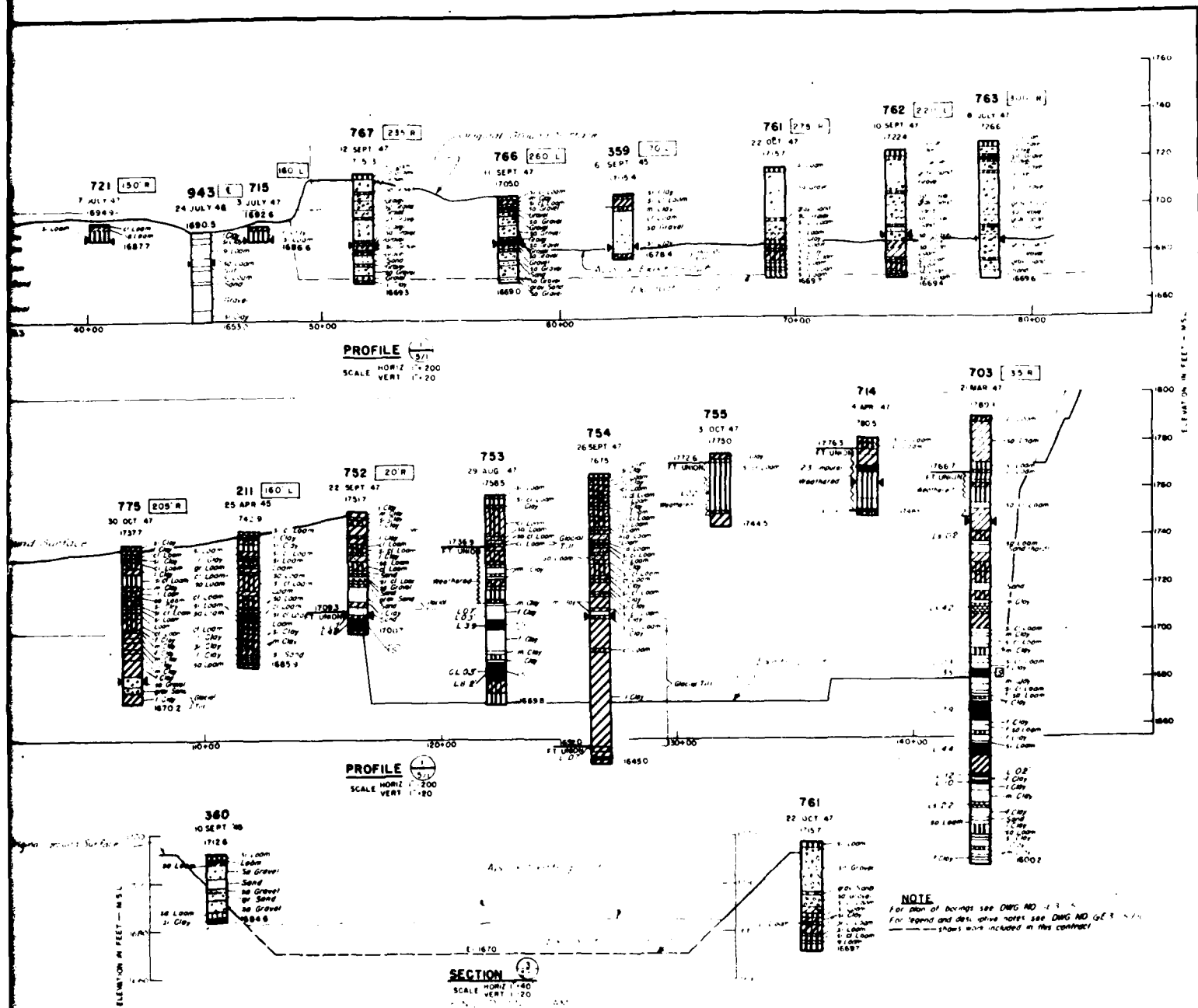


GET		DATE		DIVISION (Indicated by $\Delta$ )		S-		C-#		APP	
DEPARTMENT OF THE ARMY COMPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER BIRMINGHAM, N.S.											
MISSISSIPPI RIVER											
GARRISON DAM AND RESERVOIR											
FOUNDATION EXPLORATIONS											
RECORD OF BORINGS - 797 TO 824											
927 AND 943											
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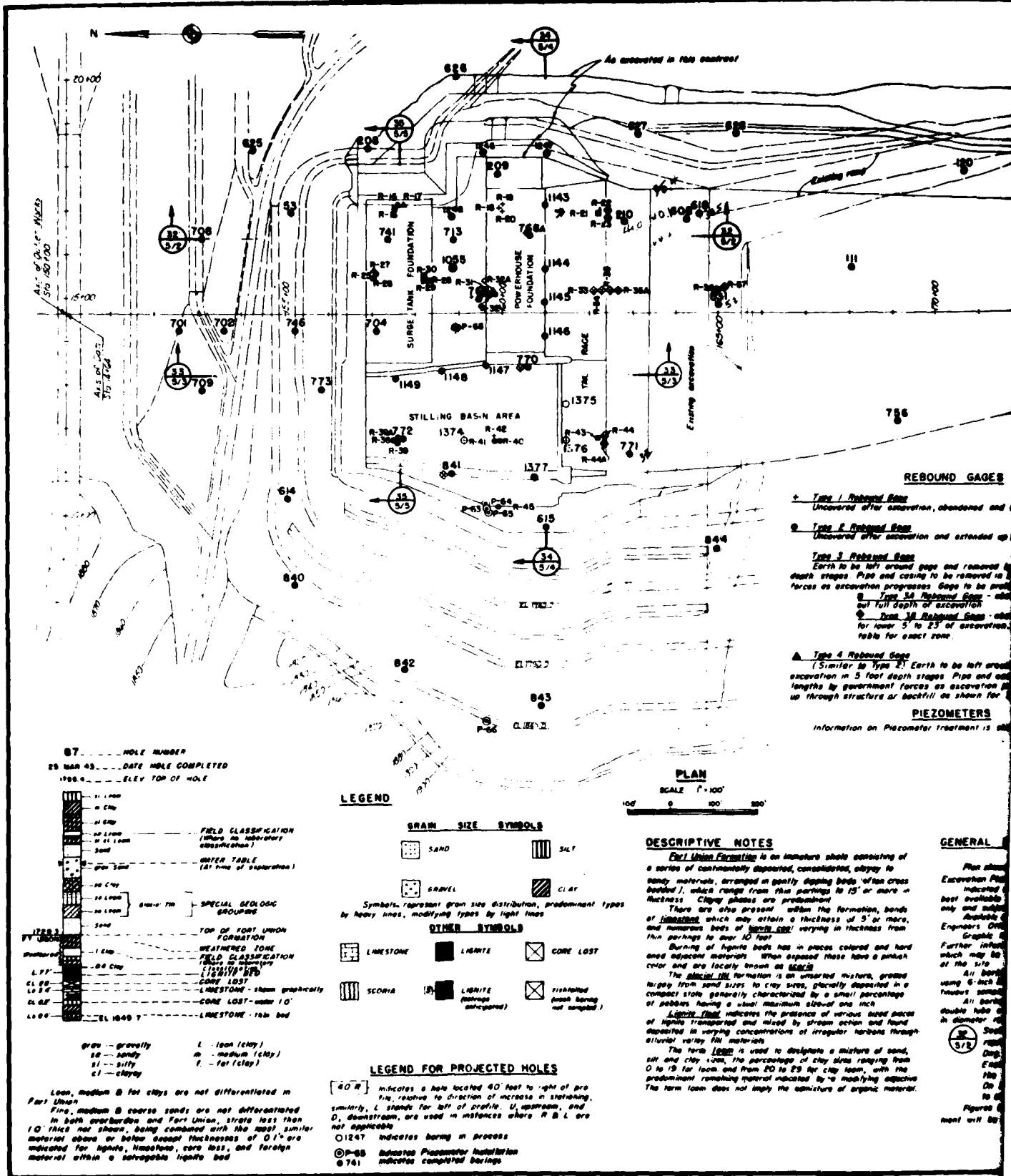
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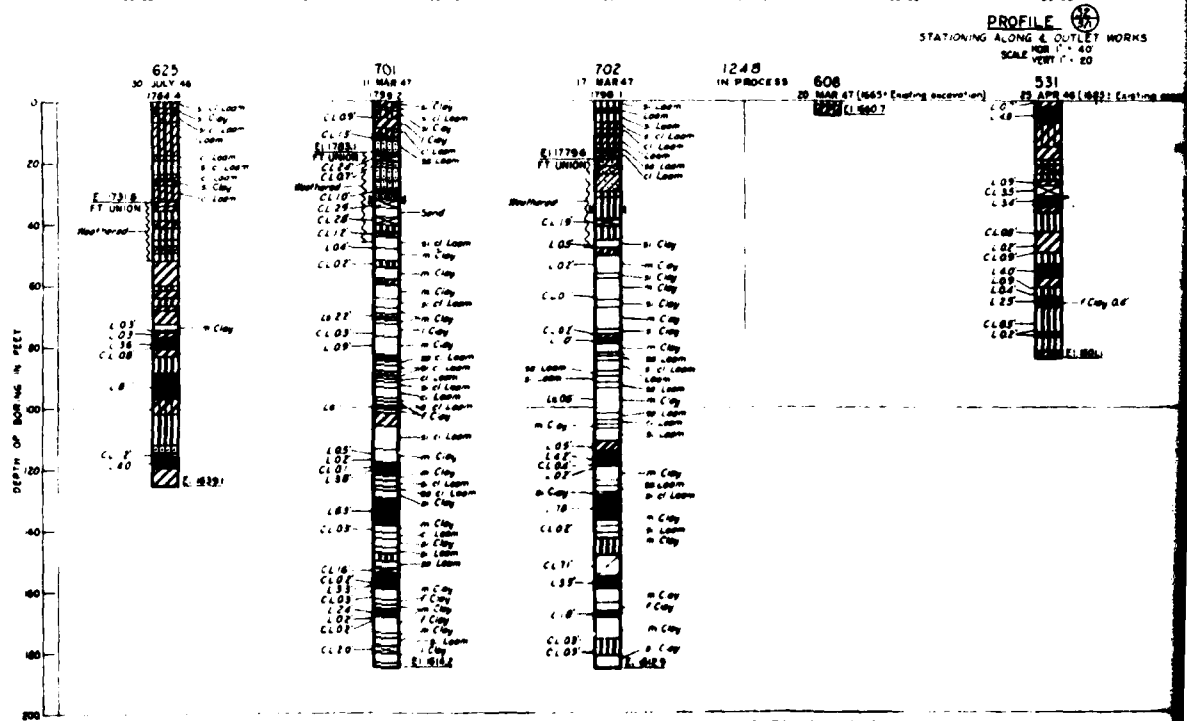
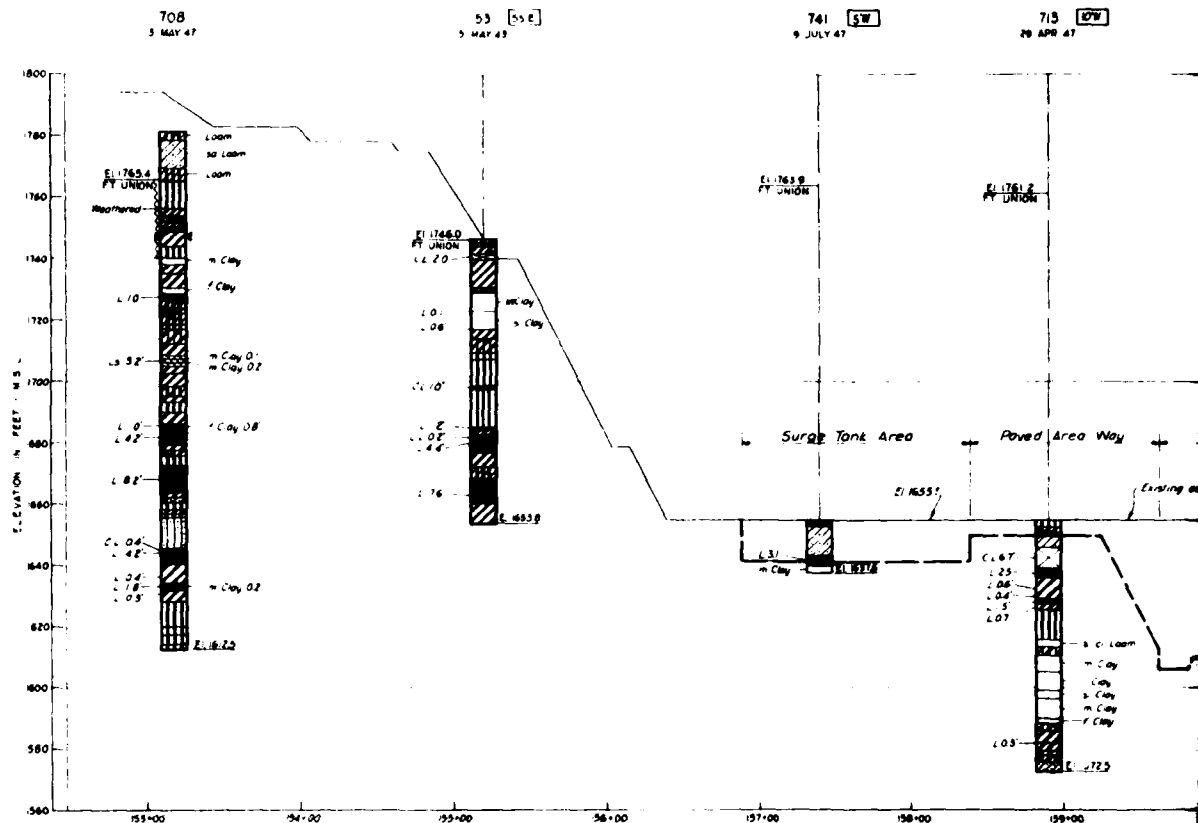




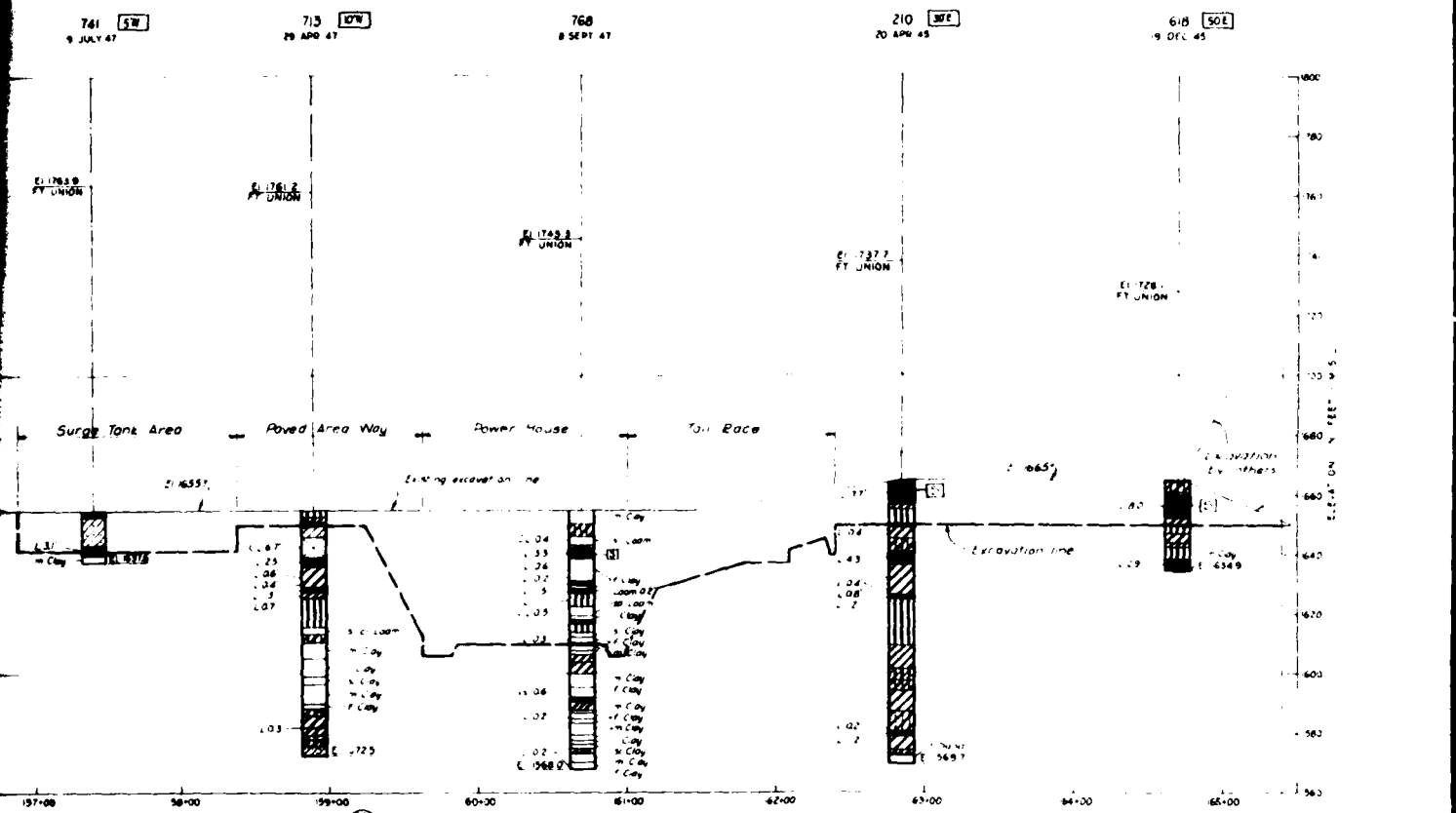
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DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER BIRMINGHAM, ALA.					
MISSISSIPPI RIVER <b>GARRISON DAM AND RESERVOIR</b> <b>FOUNDATION EXPLORATIONS</b> <b>INTAKE CHANNEL</b> <b>PROFILE AND SECTIONS</b>					
DESIGNED BY	DATE	SCALE	AUGUST 1948		
CHECKED BY	DATE	SCALE	AS SHOWN (SPEL NO.)		
APPROVED	DATE	DRAWING NUMBER	GE3-5/2		
SHEET		OF			



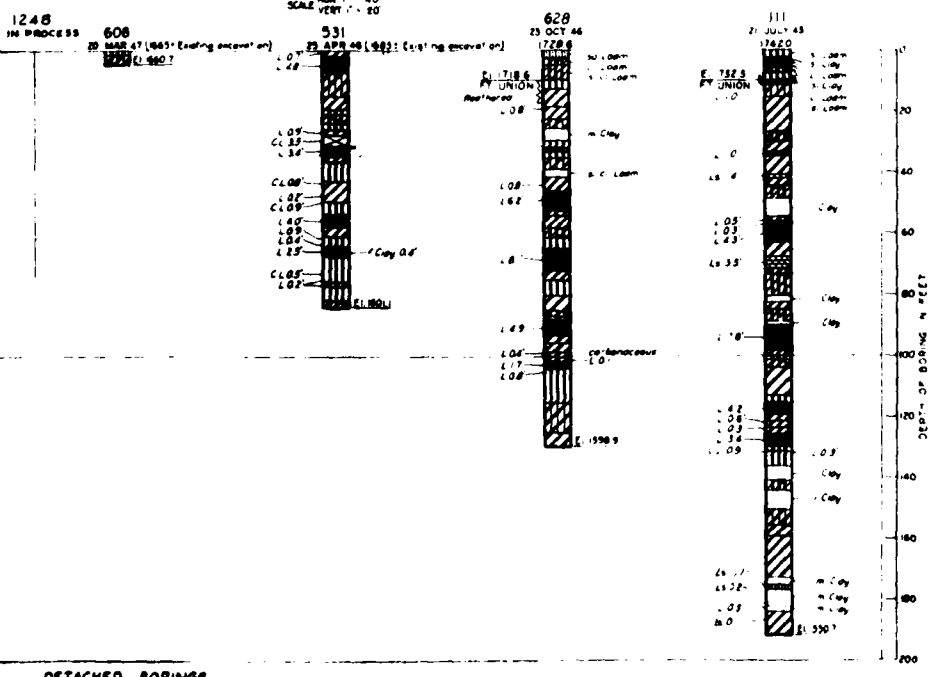




DETACHED BORINGS SCALE VERT. 1" = 20'



PROFILE  
STATIONING ALONG & OUTLET WORKS  
SCALE VERT. 1" = 20'



DETACHED BORINGS  
SCALE VERT. 1" = 20'

NOTES  
For location of borings, refer to plan view. See also notes on page 5/1.  
Borings noted in profile are shown in the plan view.  
For method of boring logs, see explanation of cross reference system, see page 5/1.

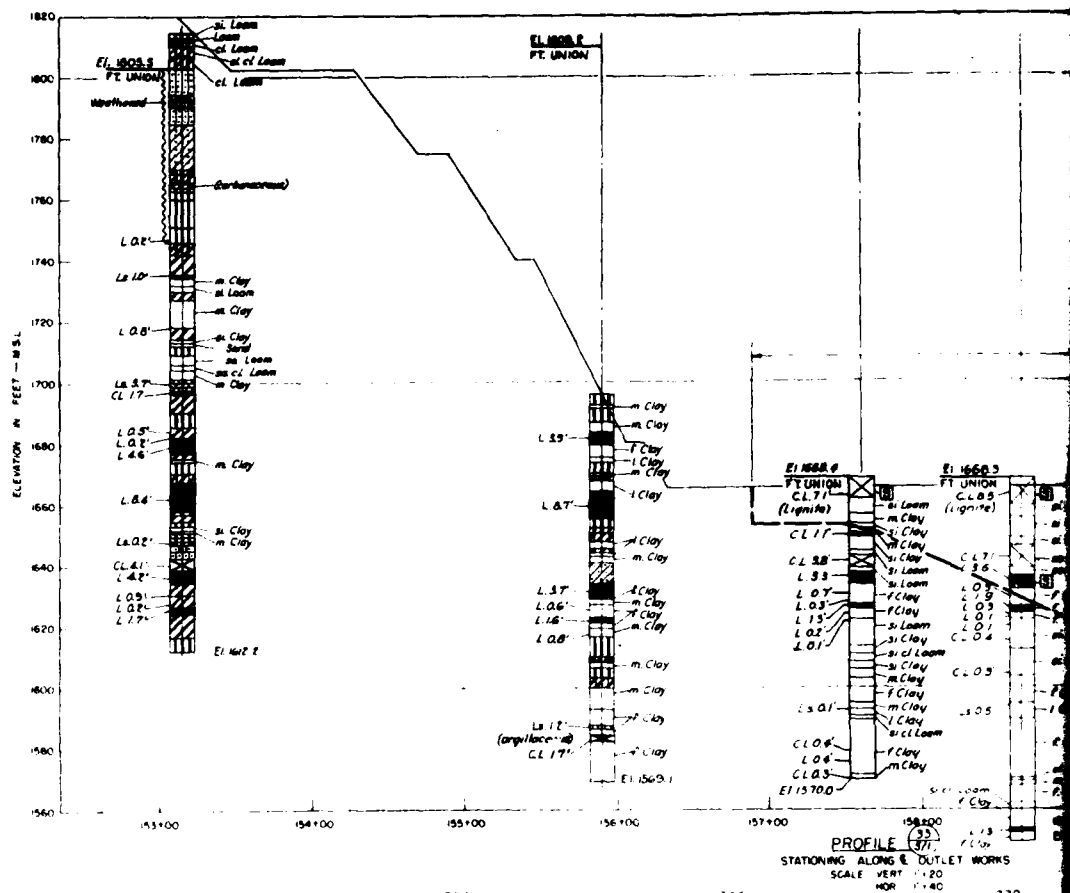
3-15-50		Revised		Revised	
DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER STATIONER 11-11					
MISSOURI RIVER GARRISON DAM AND RESERVOIR STILLING BASIN AND POWERHOUSE FOUNDATION EXPLORATION PROFILE NO. 12					
JULY 1949				DECEMBER 1949	
J. W. Albright				GOT 502	

709 209  
21 APR. 47  
184.6

773 209  
3 OCT 47

1149 21  
8 NOV. 48  
188.4

1148 21  
28 Oct. 49  
188.3

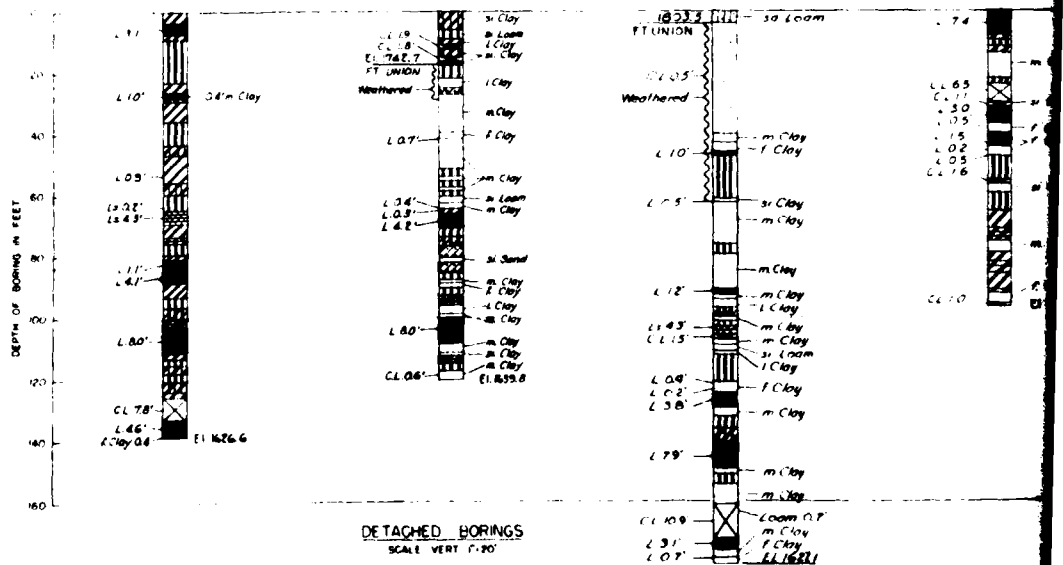


PROFILE  
STATIONING ALONG & OUTLET WORKS  
SCALE VERT. 1"=20'  
HOR. 1"=40'

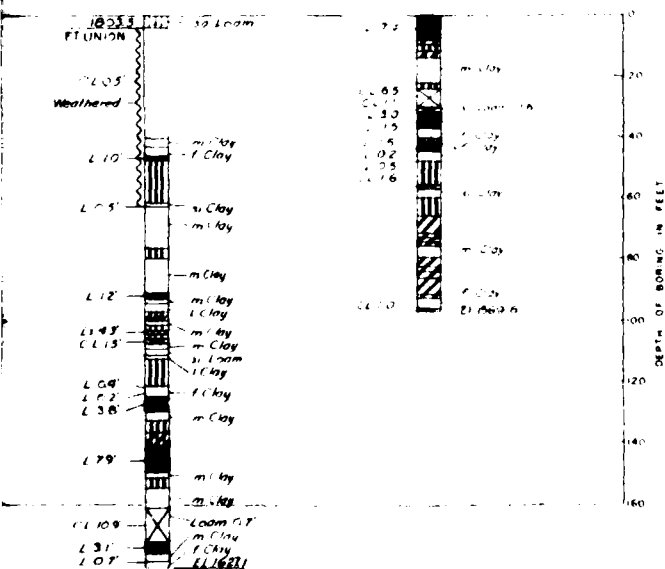
756  
25 AUG. 47  
1759.2

746  
19 JULY 47  
1876.5

772  
15 NOV. 47



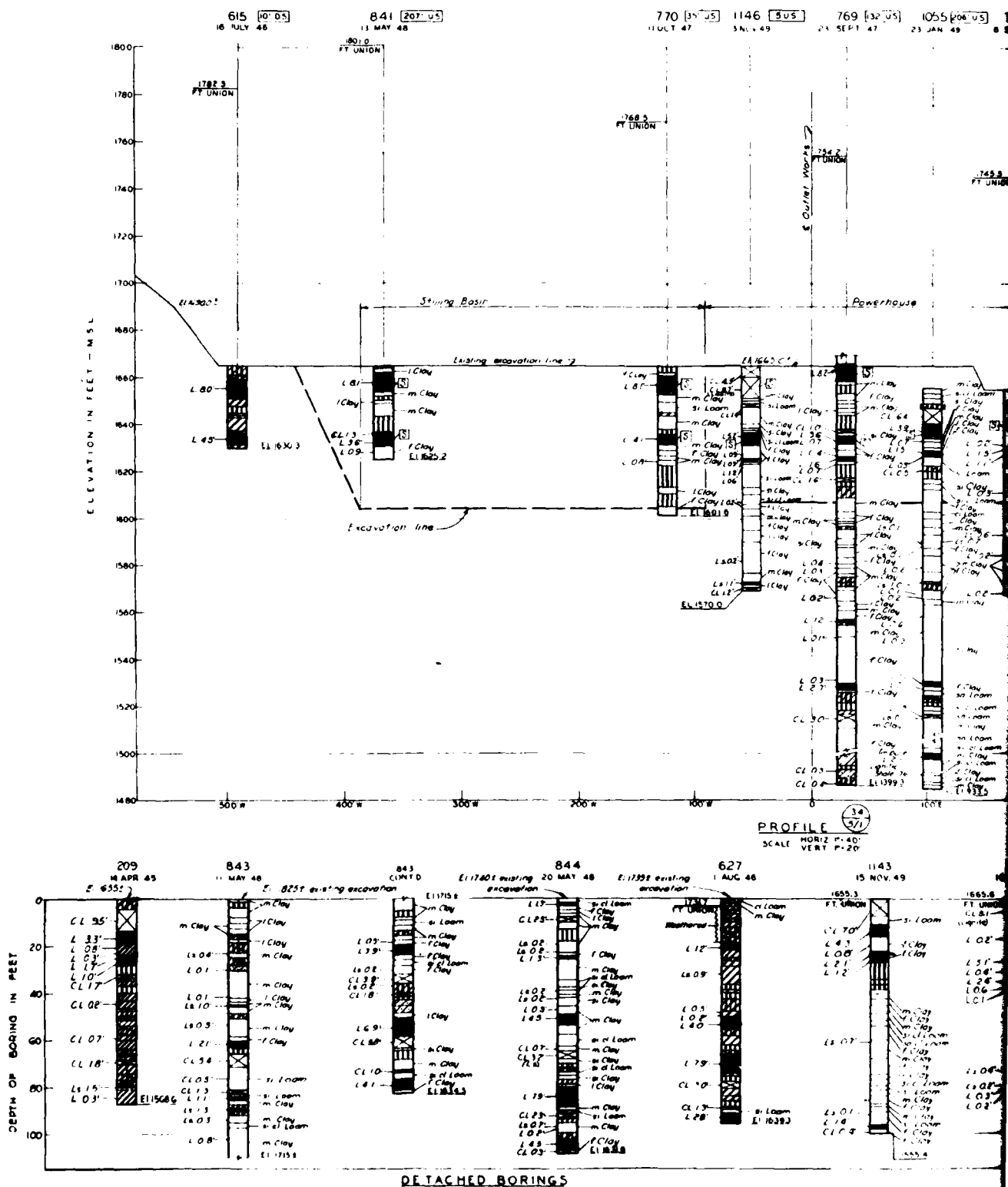
DETAILED BORINGS  
SCALE VERT. 1"=20'



4. TES  
 1. Location of B. J. G. Legend and see other notes re B. J. G. (p. 10)  
 2. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 3. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 4. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 5. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 6. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 7. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 8. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 9. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)  
 10. B. J. G. (p. 10) - see other notes re B. J. G. (p. 10)

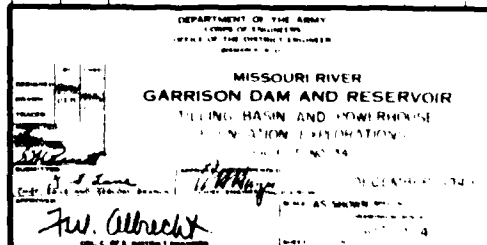
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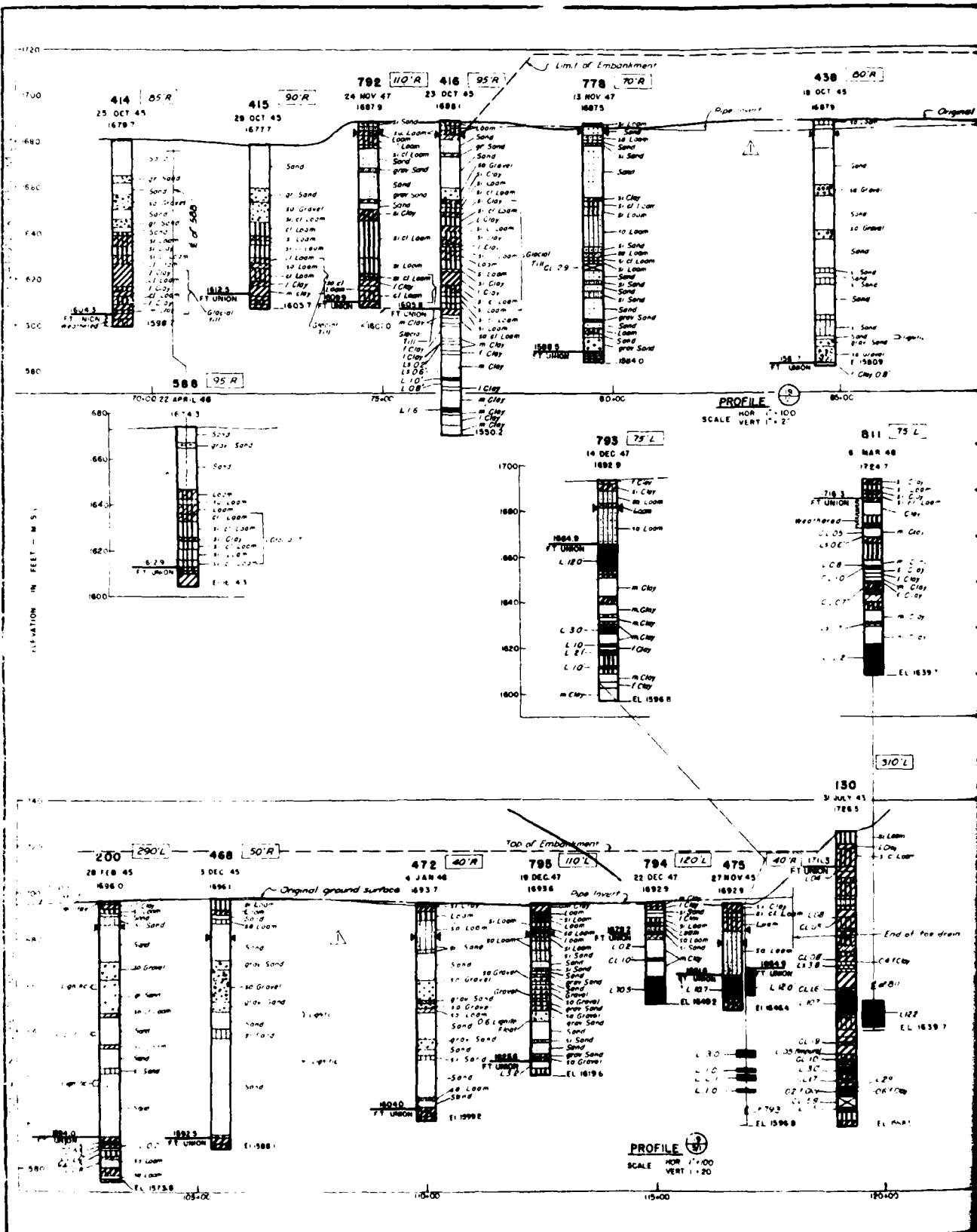


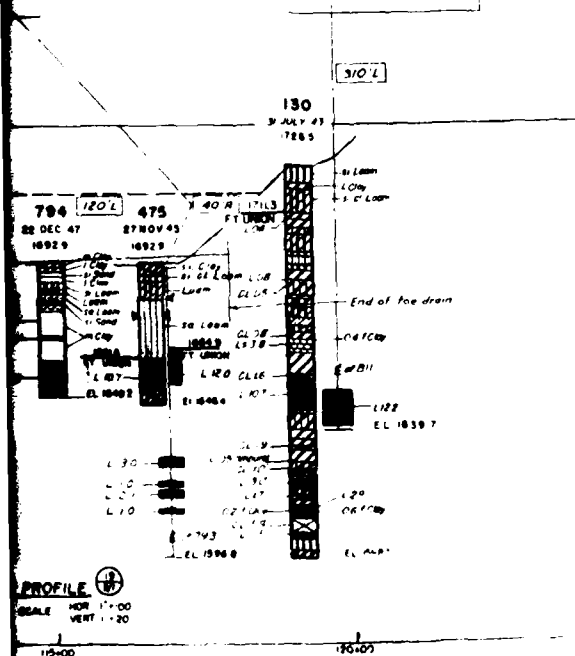
For location of the legend, see also notes on Eng 40  
607-541







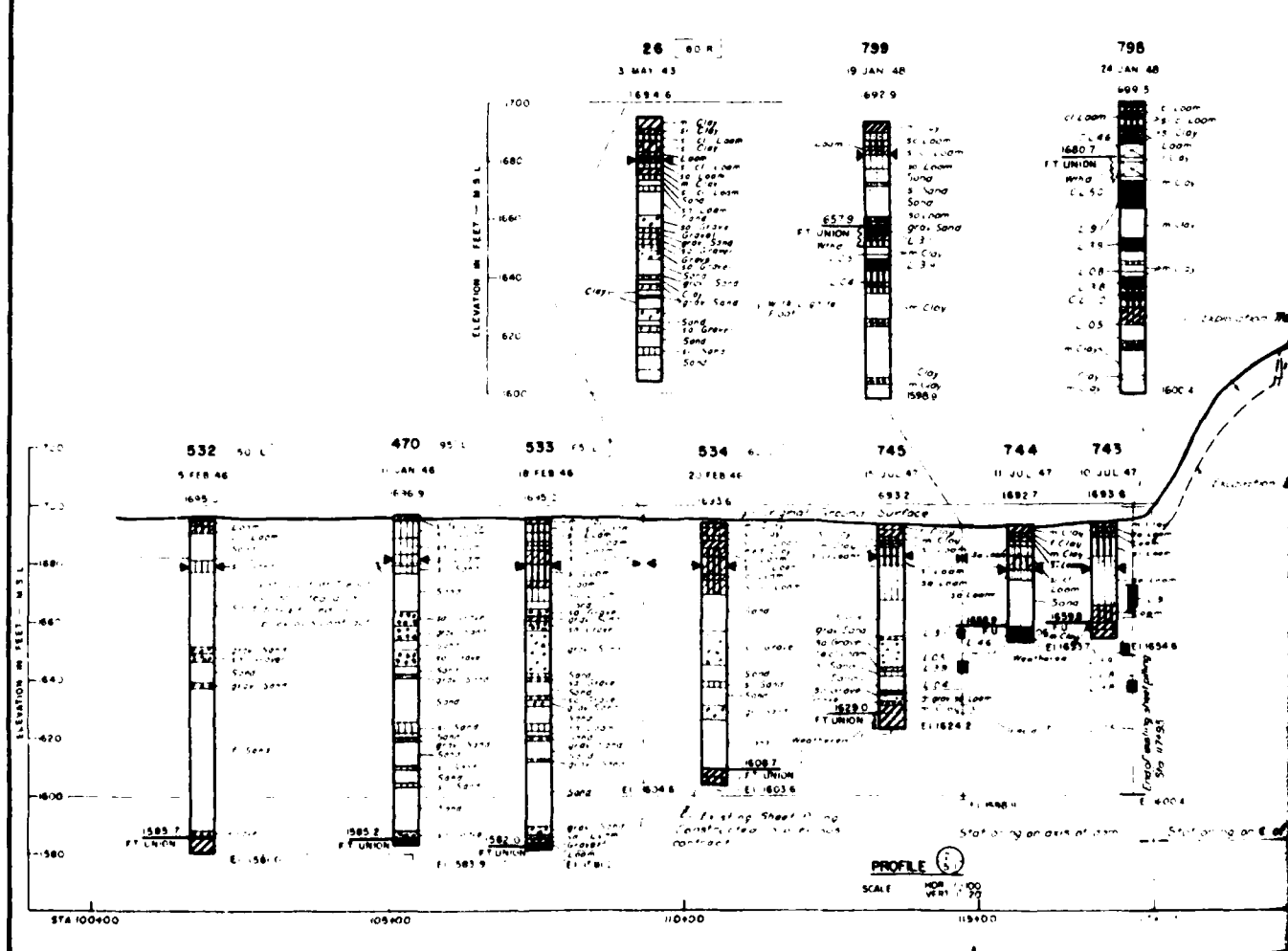
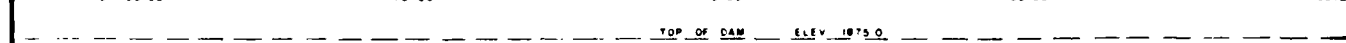


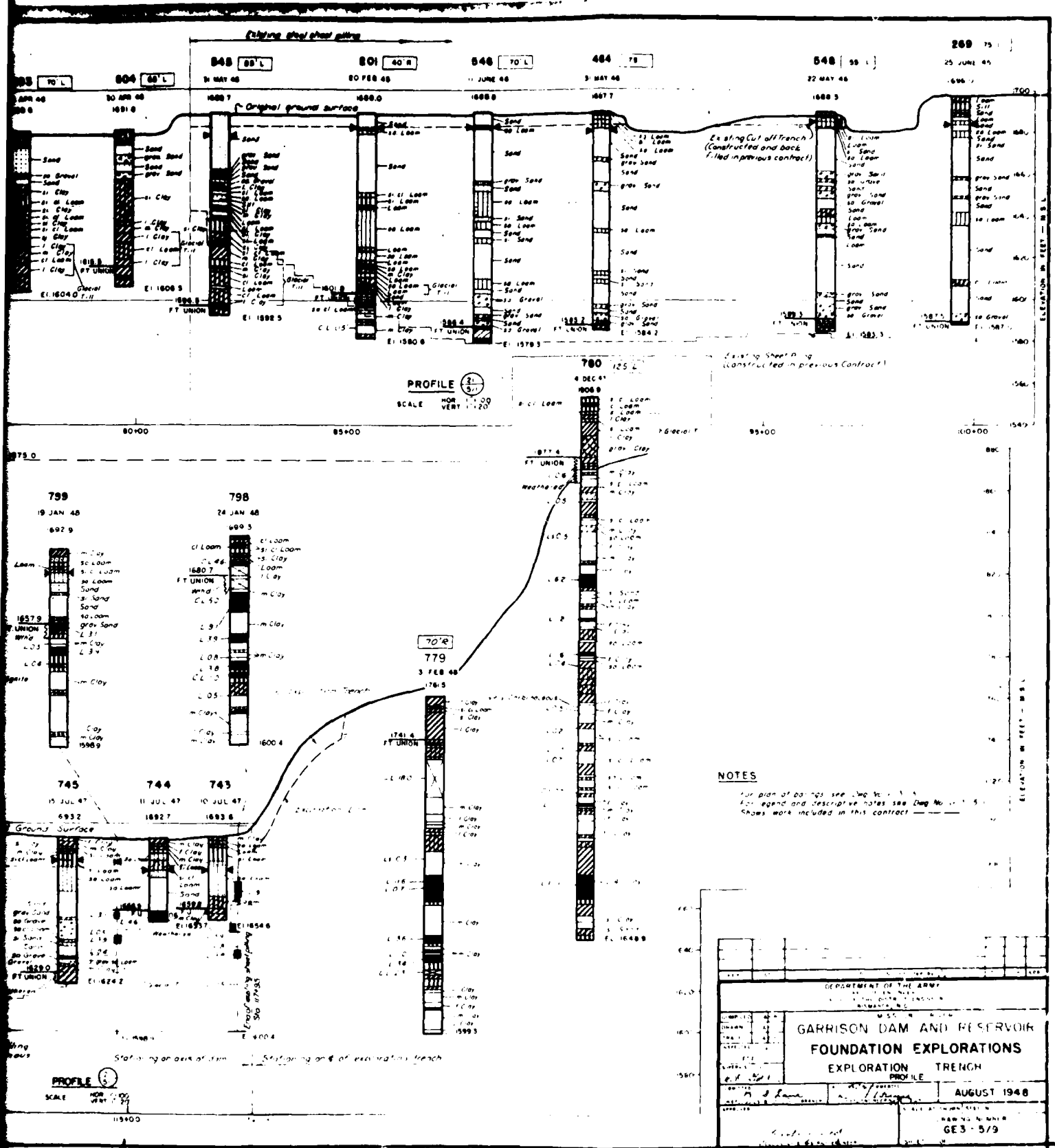


## NOTES

For place of business see page 2  
For legal name of company see page 2  
— — — — —

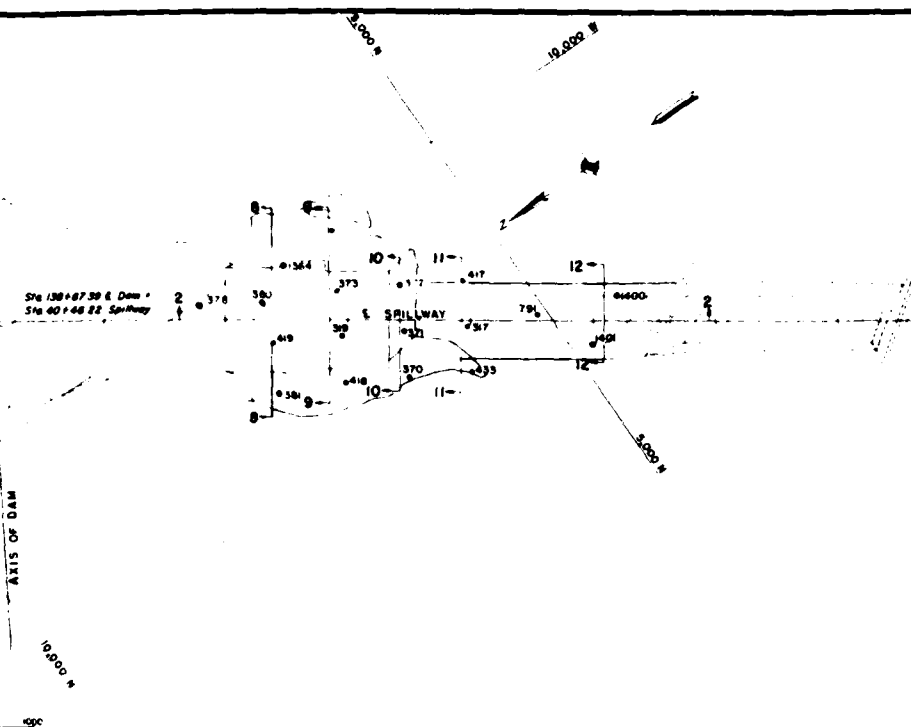
[illegible]







Loam, medium & fat clays are not differentiated in Fort Union.



**DESCRIPTIVE NOTES**

Fort Union Formation is a Tertiary clay-shale. It consists of a series of continentally deposited compact, clayey to sandy materials, arranged in gently dipping beds (often cross bedded), which range from thin partings to 15' or more in thickness. Clayey phases are predominant.

Within the formation there are horizons of limestone and sandstone which may reach a thickness of about 5'. Often these horizons are discontinuous in the form of concretions which may attain a thickness of 5' or more and may be greater than 25' in diameter.

Ignite beds vary in thickness from thin partings to over 10', and are usually water bearing, particularly the thicker beds.

Burning of Ngaité beds has in places colored and hardened adjacent materials. When exposed these have a pinkish color and are locally known as scoria.

The glacial till formation is an unsorted mixture, graded largely from sand sizes to clay sizes, glacially deposited in a compact state generally characterized by a small percentage of pebbles having a usual maximum size of one inch. Occasional cobbles and boulders are also found in the till.

Ignite float indicates the presence of various sized pieces of ignite transported and mixed by stream action and found deposited in varying concentrations at irregular horizons in the glacial or alluvial materials.

The term loam is used to designate a mixture of sand, silt and clay sizes, the percentage of clay sizes ranging from 0 to 19 for loam and from 20 to 29 for clay loam, with predominant remaining material indicated by a modifying adjective. The term loam does not imply the admixture of organic material.

### GENERAL NOTES

Plan shows generalized excavation lines, for details see  
Excavation Plans.

Indicated water table elevations, although derived from best available data, should be regarded as approximate only and subject to considerable variations.

Available samples may be inspected at the Corps of Engineers Office at the dam site.

Graphic logs give boring information in condensed form. Further information is shown on the complete boring logs which may be inspected at the Corps of Engineers Office at the site.

Generally borings in overburden made by churn type rig using 6 inch inside diameter open end drive tube. Continuous samples recovered.

Generally borings in Port Union made by rotary type rig using double tube core barrel. Continuous core 3 1/2 inches in diameter recovered.

## NOTES

NOTES  
For profiles and sections of Spillway  
see Dwg Nos GE 10 5/1 5/2 5/3 5/4  
5/5 5/6 5/7 5/8 5/9

KEY DATE REVISION AUGUST 67 BY C.M.B. L.W.

U S ARMY  
CORPS OF ENGINEERS  
OFFICE OF THE DISTRICT ENGINEER  
BOSWELL'S F

MISSOURI RIVER  
**GARRISON DAM AND RESERVOIR**  
FOUNDATION EXPLORATIONS  
SPILLWAY  
PLAN AND LEGEND

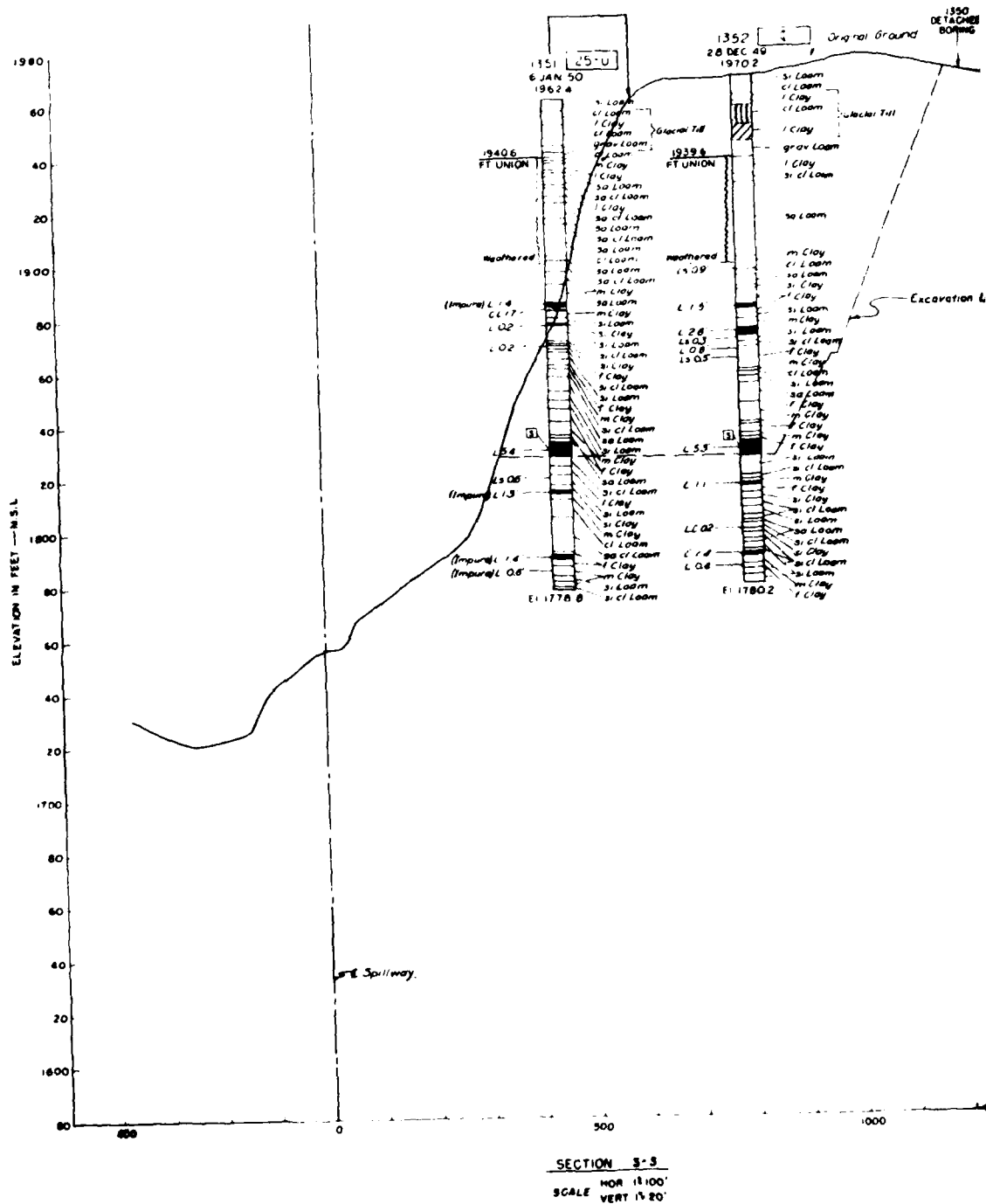
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DATE 8-10-51

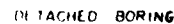
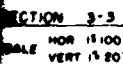
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VERTICAL

GEIO-9/1



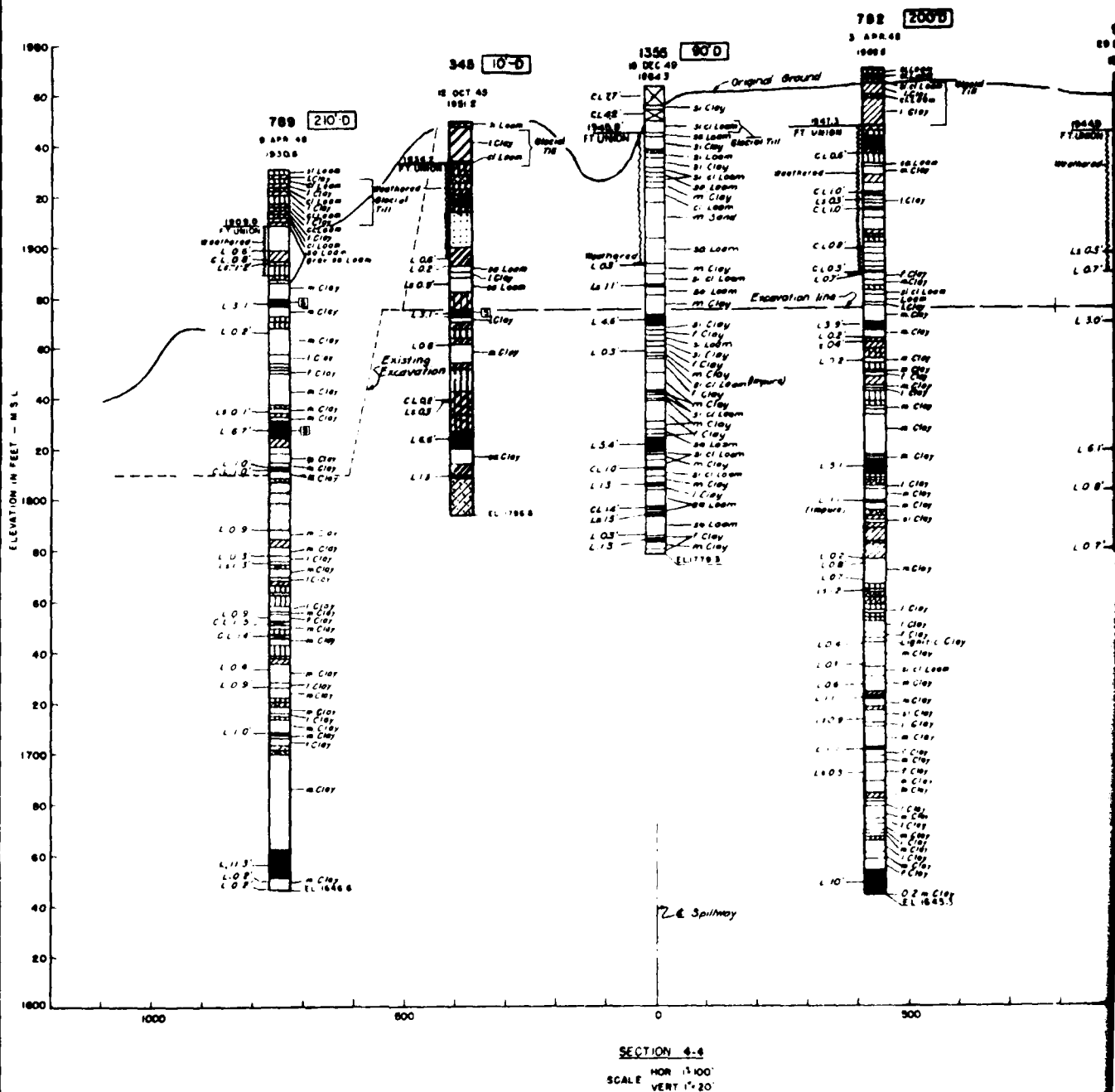


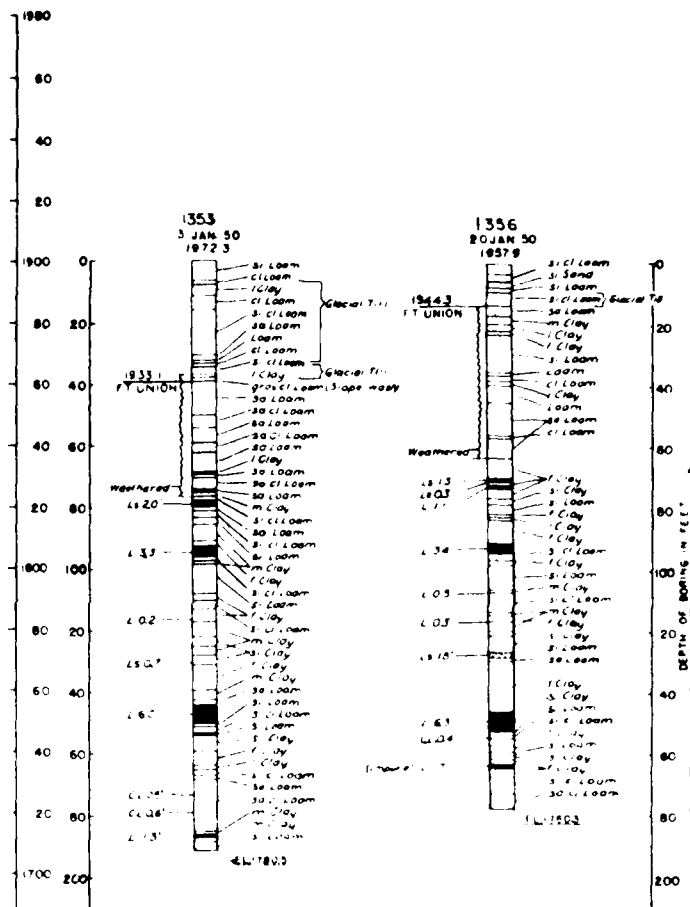
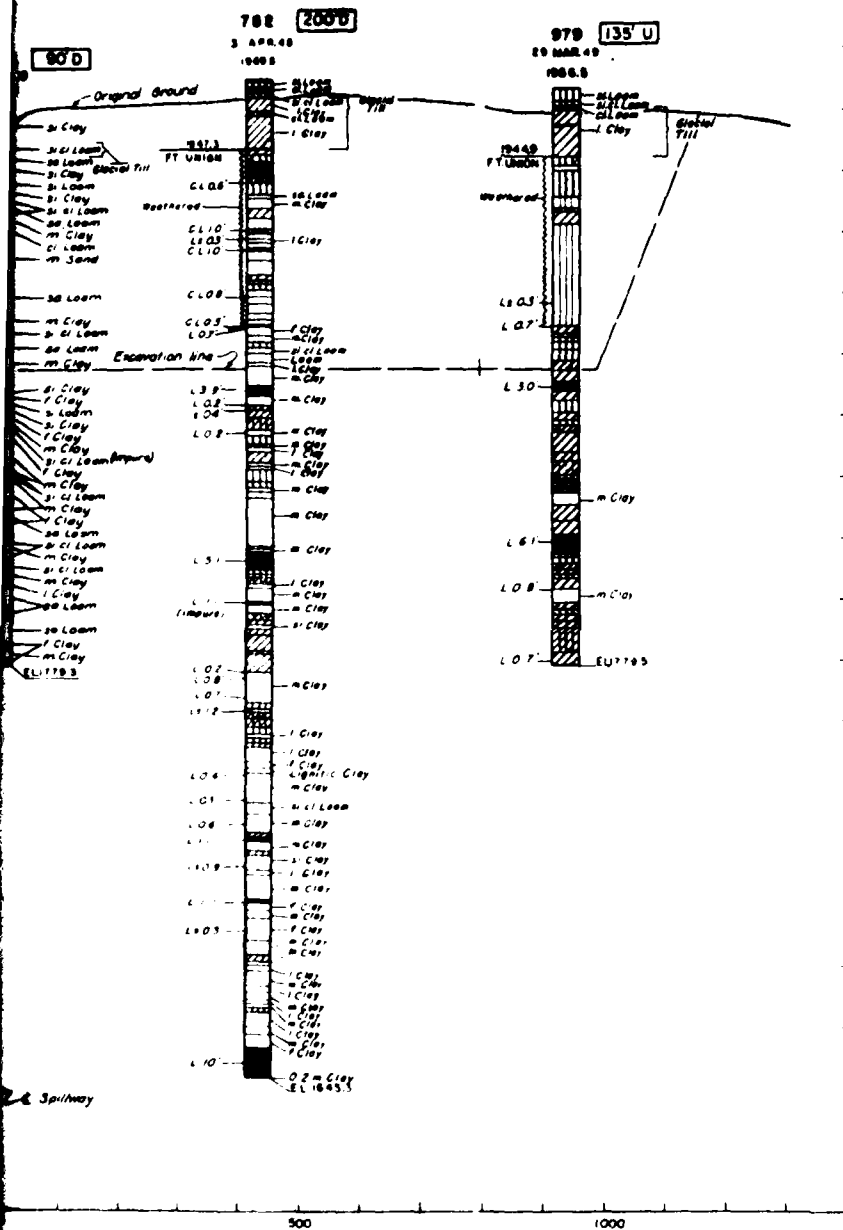




For location of Plan and Profiles of Spillway  
see Day No. GE 10-5/1  
For Legend see Day No. GE 10-5/1

U.S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER BOSTON		MOISSOURI RIVER GARRISON DAM AND RESERVOIR FOUNDATION EXPLORATIONS SPILLWAY SECTION 3-B AND DEPTH BORING	
APPROVED: <i>[Signature]</i> DISTRICT ENGINEER		AUGUST 1951	
RECEIVED: <i>[Signature]</i> DISTRICT ENGINEER		DATE: AUG 1 1951	





#### DETACHED BORINGS

#### NOTES

For location of Plan and Profiles of Spillway  
see Dwg No GE 10-5/1

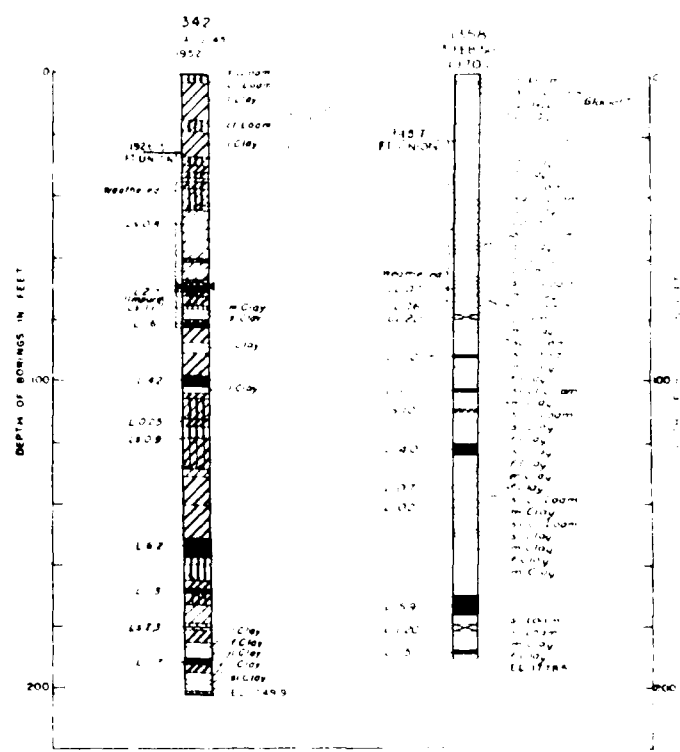
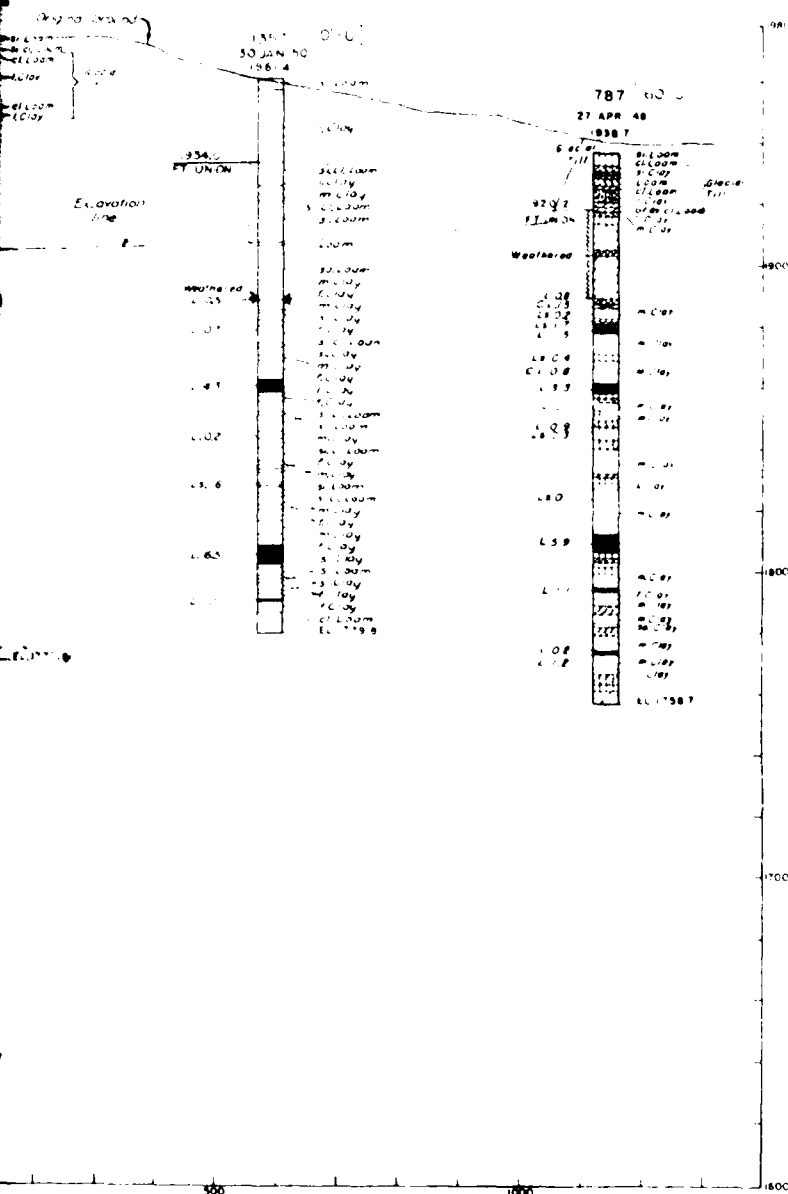
For legend see Dwg No GE 10-5/1

MISSOURI RIVER			
GARRISON DAM AND RESERVOIR			
FOUNDATION EXPLORATION			
SPILLWAY			
SECTION 4 AND DETACHED BORINGS			
DATE		AUGUST 1951	
BY		GE 10-5/4	
NO. 1	1353	DATE	3 JAN 50
NO. 2	1356	DATE	20 JAN 50
NO. 3		DATE	
NO. 4		DATE	
NO. 5		DATE	
NO. 6		DATE	
NO. 7		DATE	
NO. 8		DATE	
NO. 9		DATE	
NO. 10		DATE	



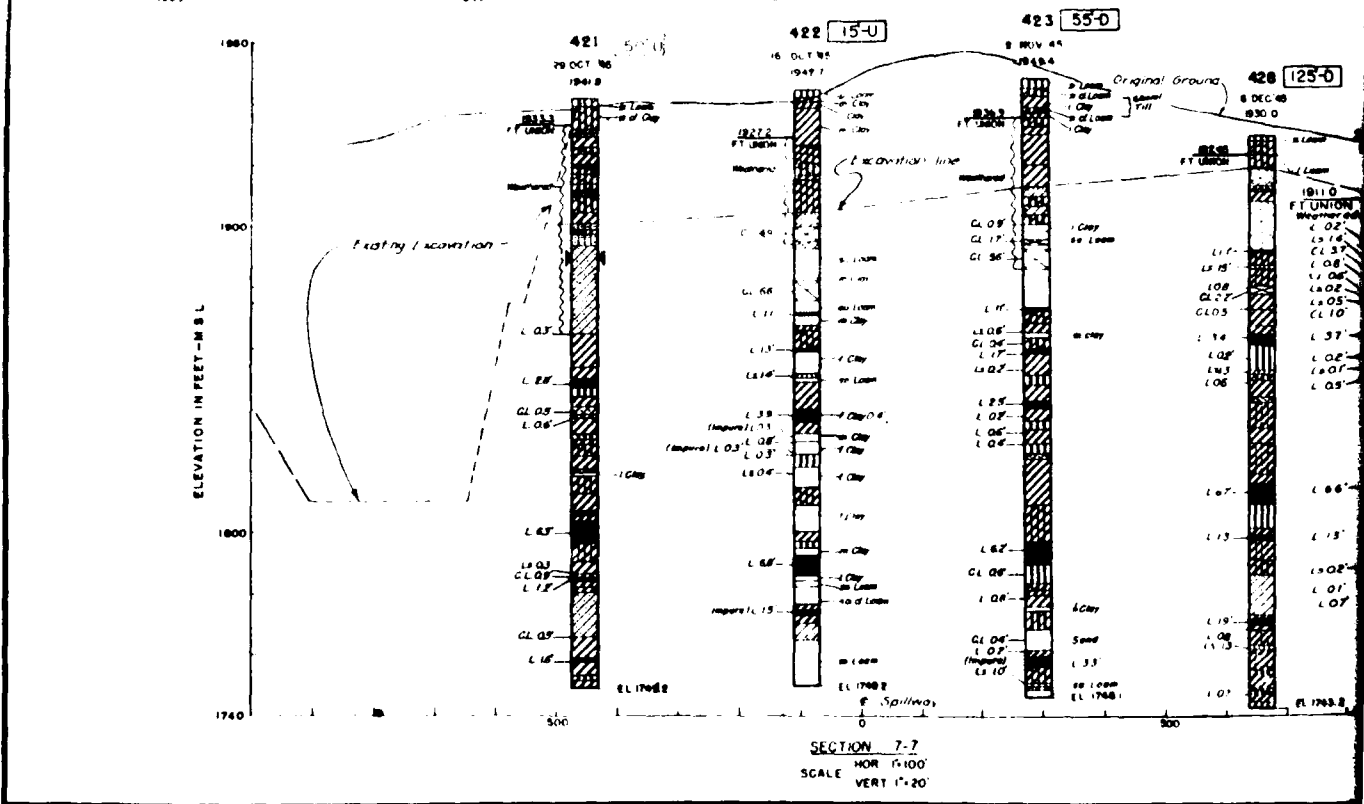


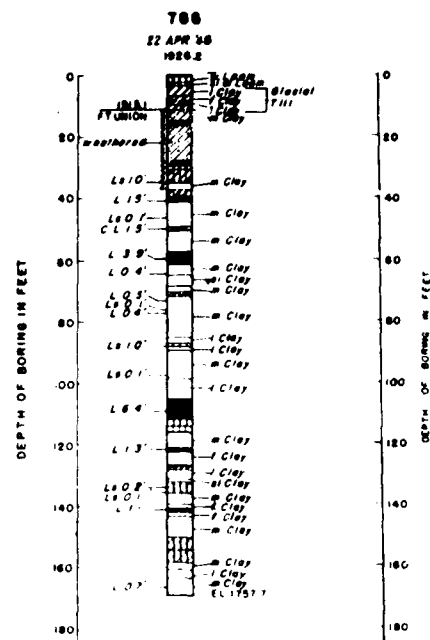
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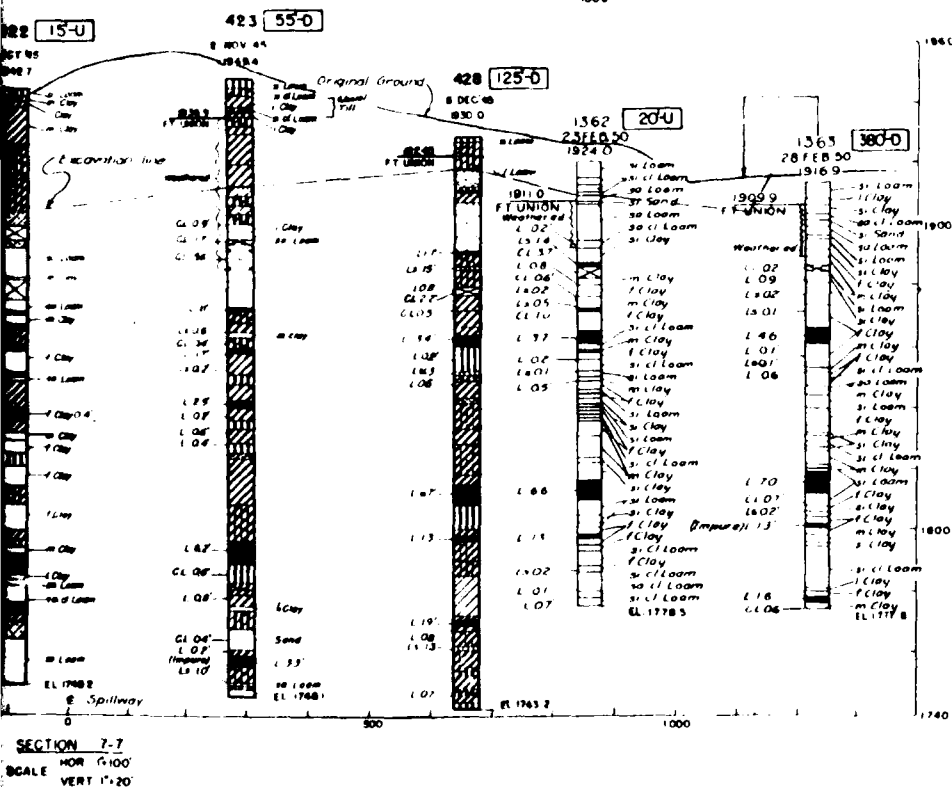
NOTES  
For location of Plan and Profiles of Spillway  
see Div. No. GE 10-5/1  
For Legend, see Div. No. GE 10-5/1

U.S. ARMY  
CORPS OF ENGINEERS  
OFFICE OF THE DISTRICT ENGINEER  
MISSOURI RIVER  
GARRISON DAM AND RESERVOIR  
FOUNDATION EXPLORATIONS  
SPILLWAY  
SECTION 5.5 AND DETACHED BORINGS  
AUGUST 1951  
GE 10-5/3





DETACHED BORING



NOTES  
For location of Plan and Profiles of Spillway,  
see Dwg No. of 10-3/1  
For Legend, see Dwg No. of 10-3/1

REF ID: A67098

NOV 1951  
U S ARMY  
CORPS OF ENGINEERS  
OFFICE OF THE DISTRICT ENGINEER  
ST. LOUIS, MO.

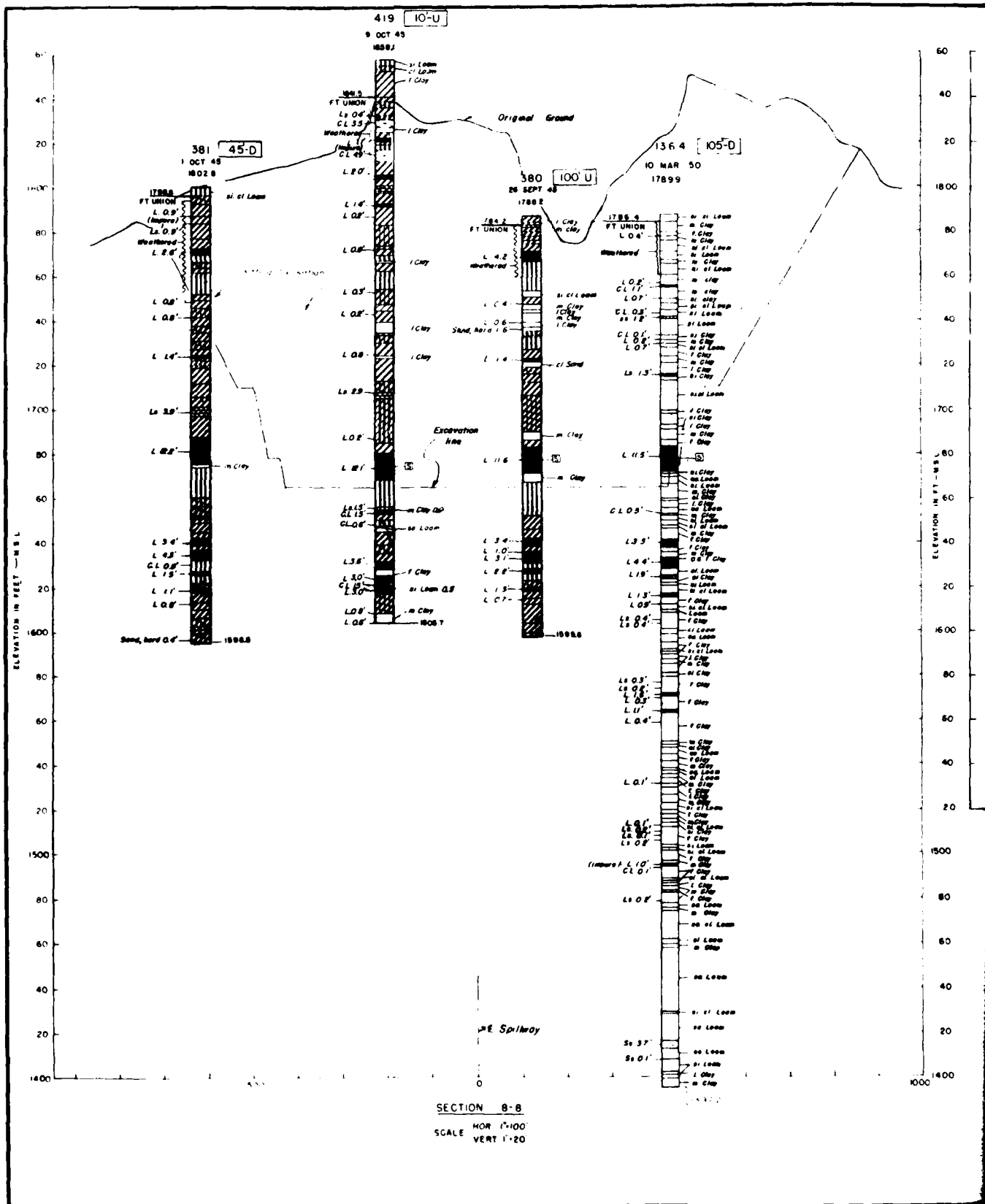
MISSOURI RIVER  
GARRISON DAM AND RESERVOIR  
FOUNDATION EXPLORATIONS  
SPILLWAY

SECTIONS 5-6 - 7-7 • DETACHED BORING

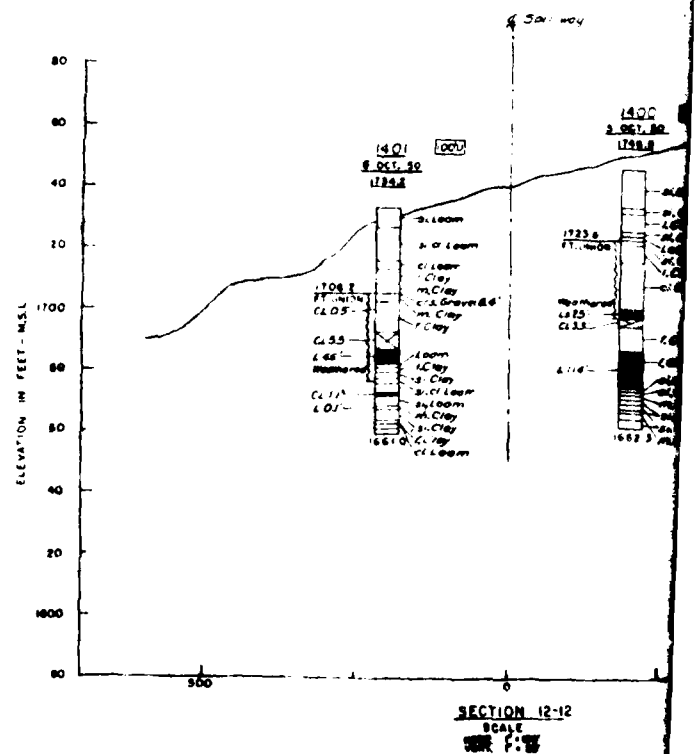
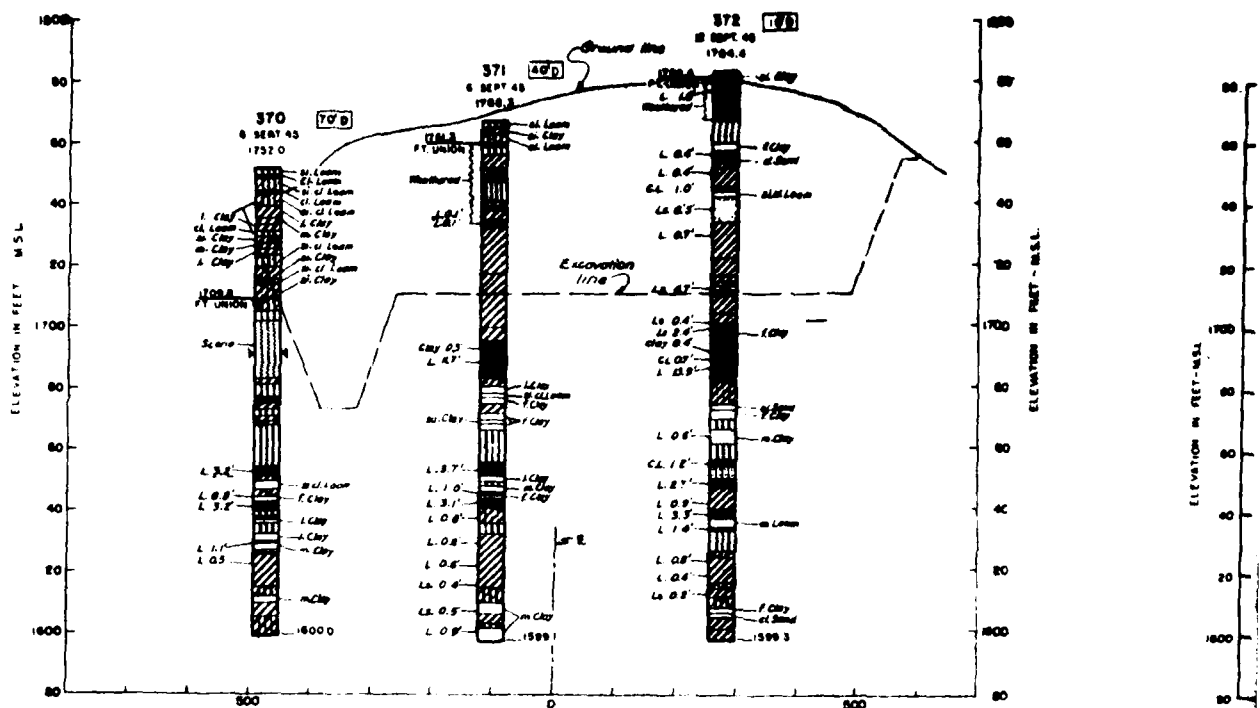
AUGUST 1951

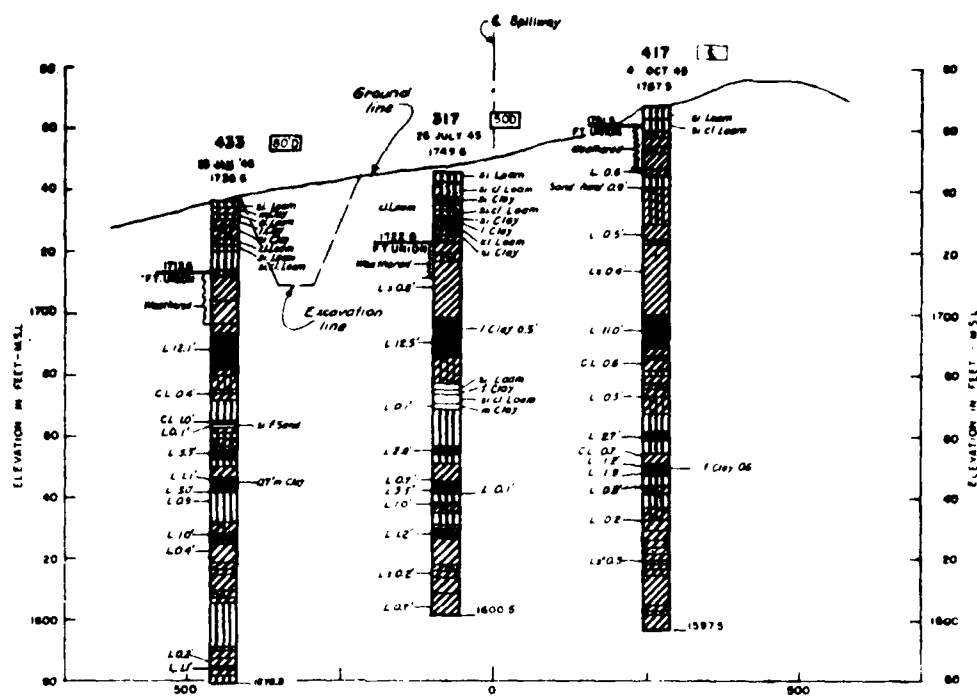
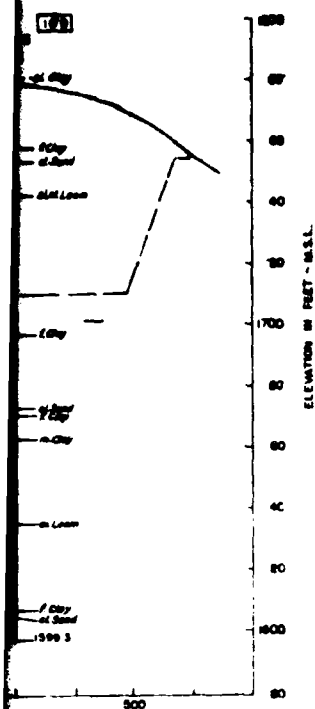
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EXPIRATION DATE -

GE 10-576

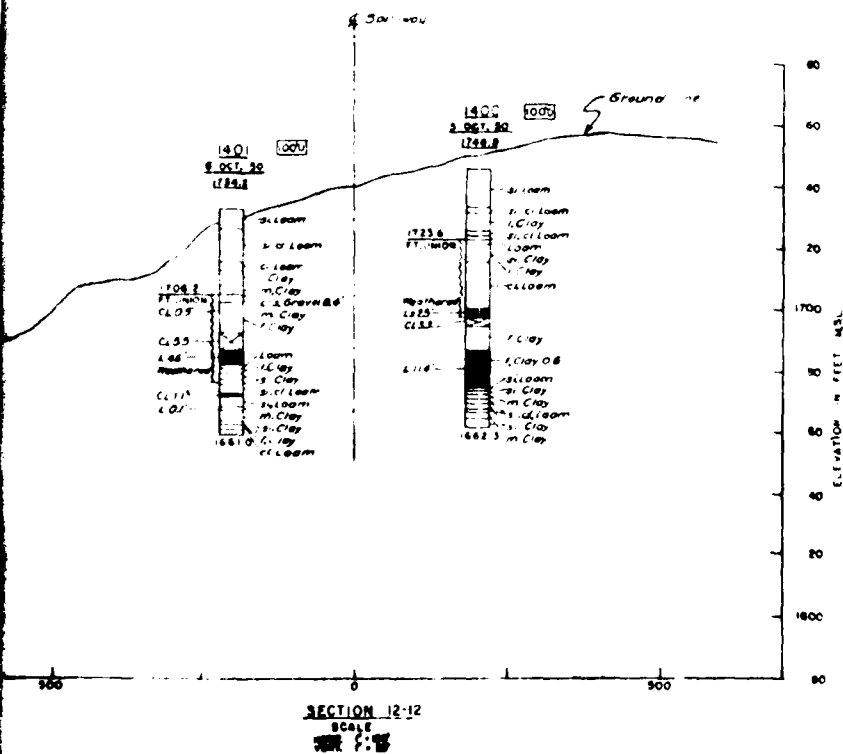








SECTION 12-11  
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VERT. 1" = 20'

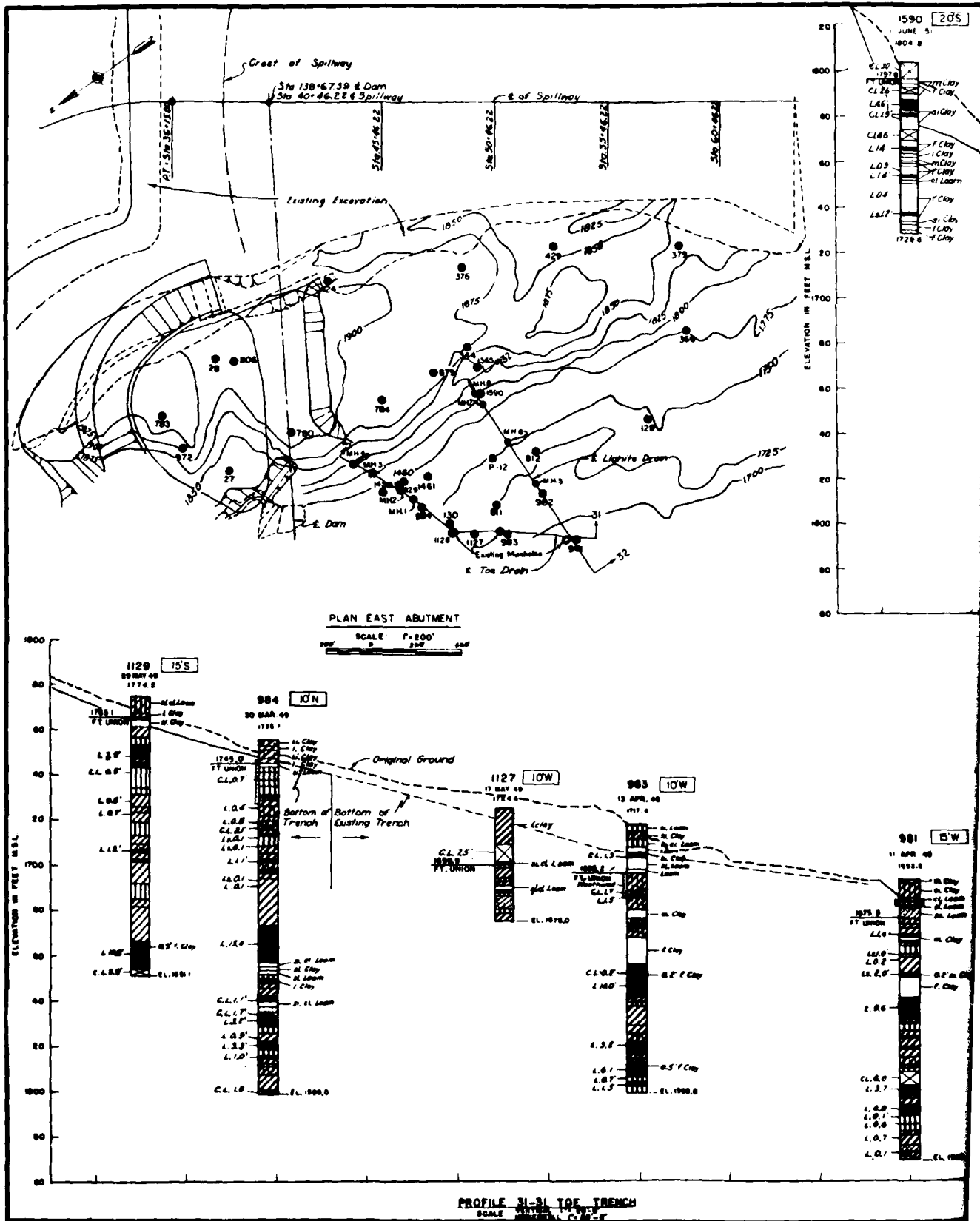


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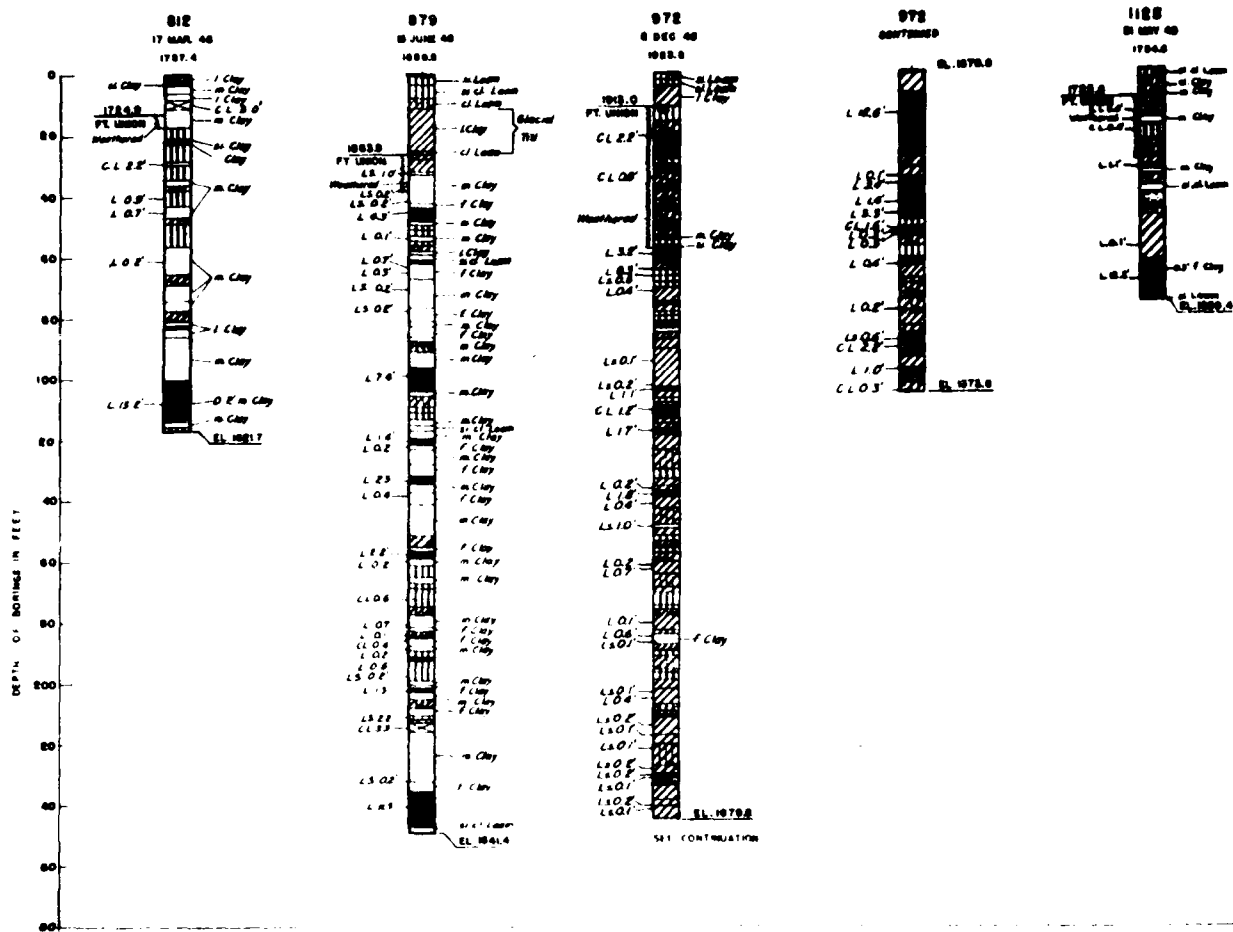
NOTES  
For location of Pw and Slope of Spillway  
see Dwg. No. GE 10-5-1  
For legend, see Dwg. No. GE 10-5-2

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR FOUNDATION EXPLORATION SPILLWAY SECTIONS 10-10, 11-11, 12-12 AUGUST 1951 GE 10-5-8	

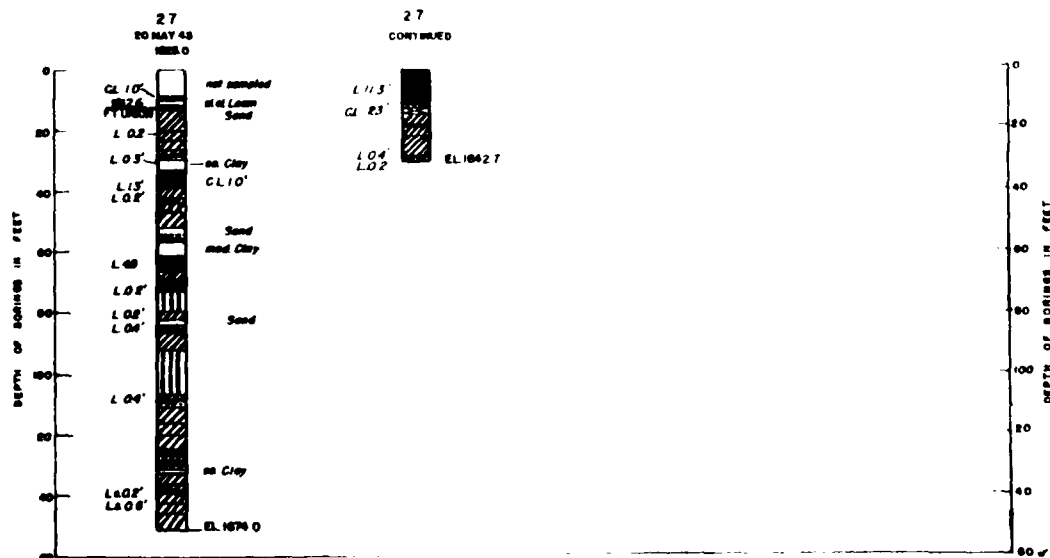


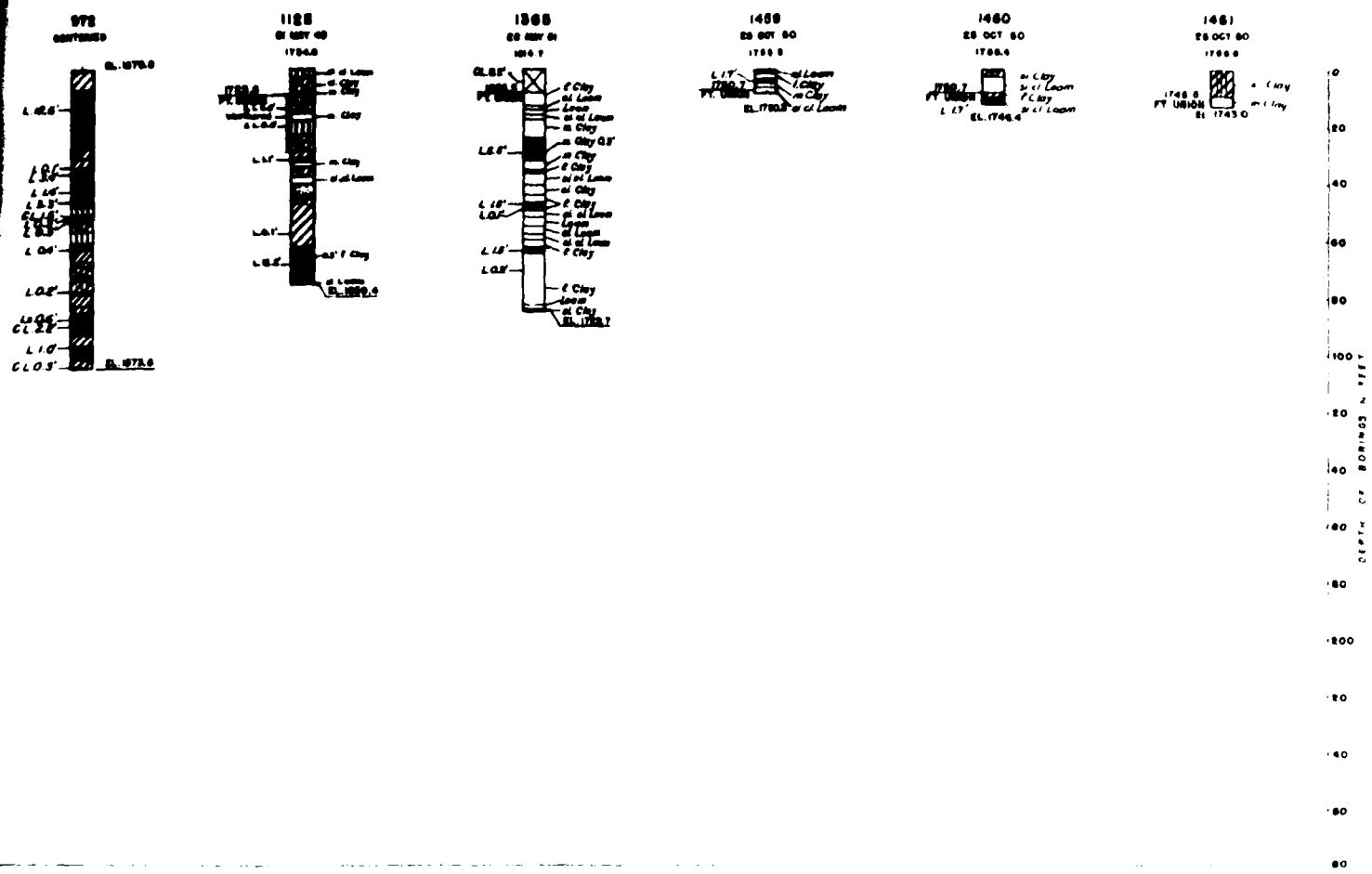




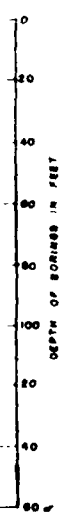


# DETACHED BORINGS



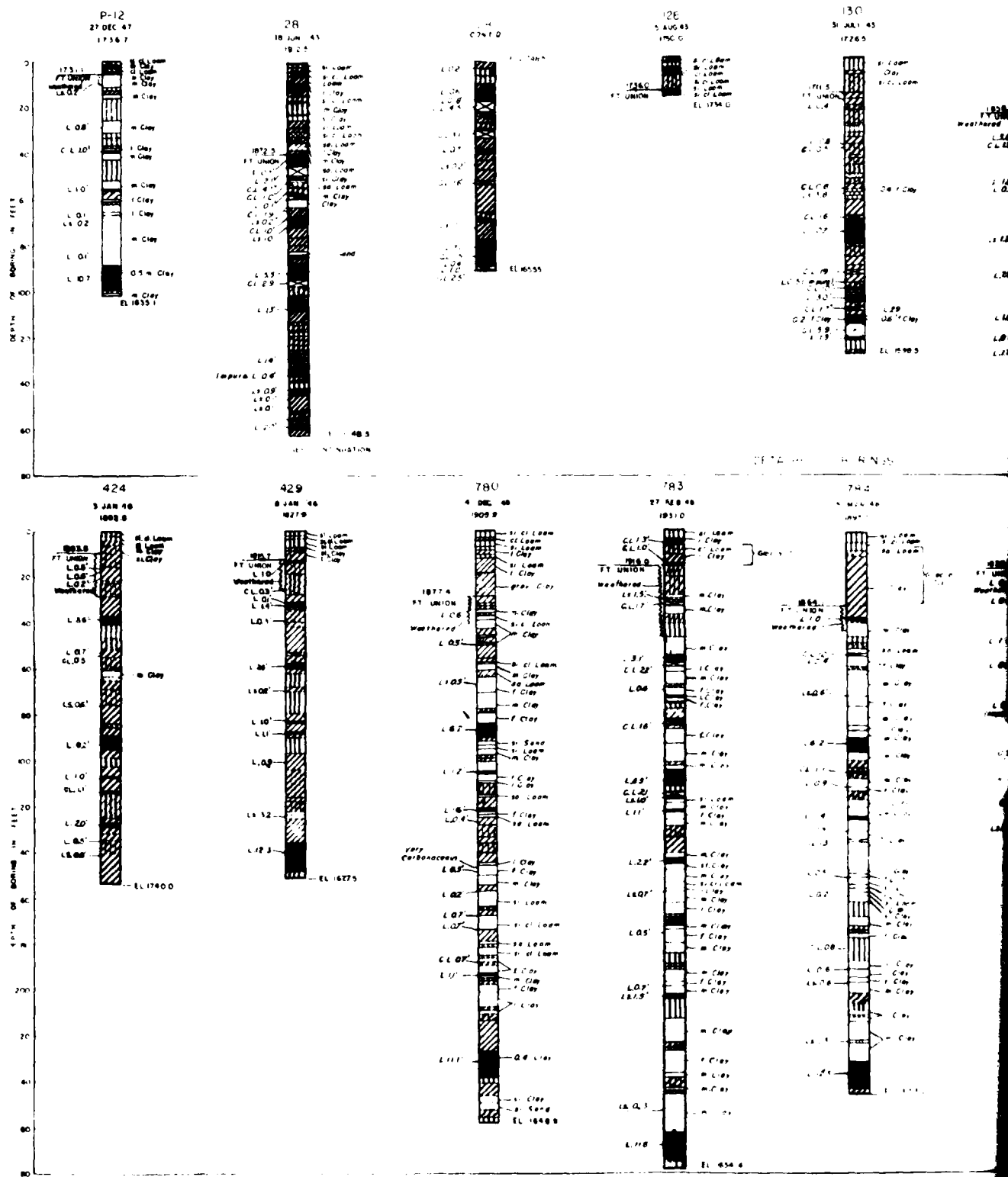


DETACHED BORINGS



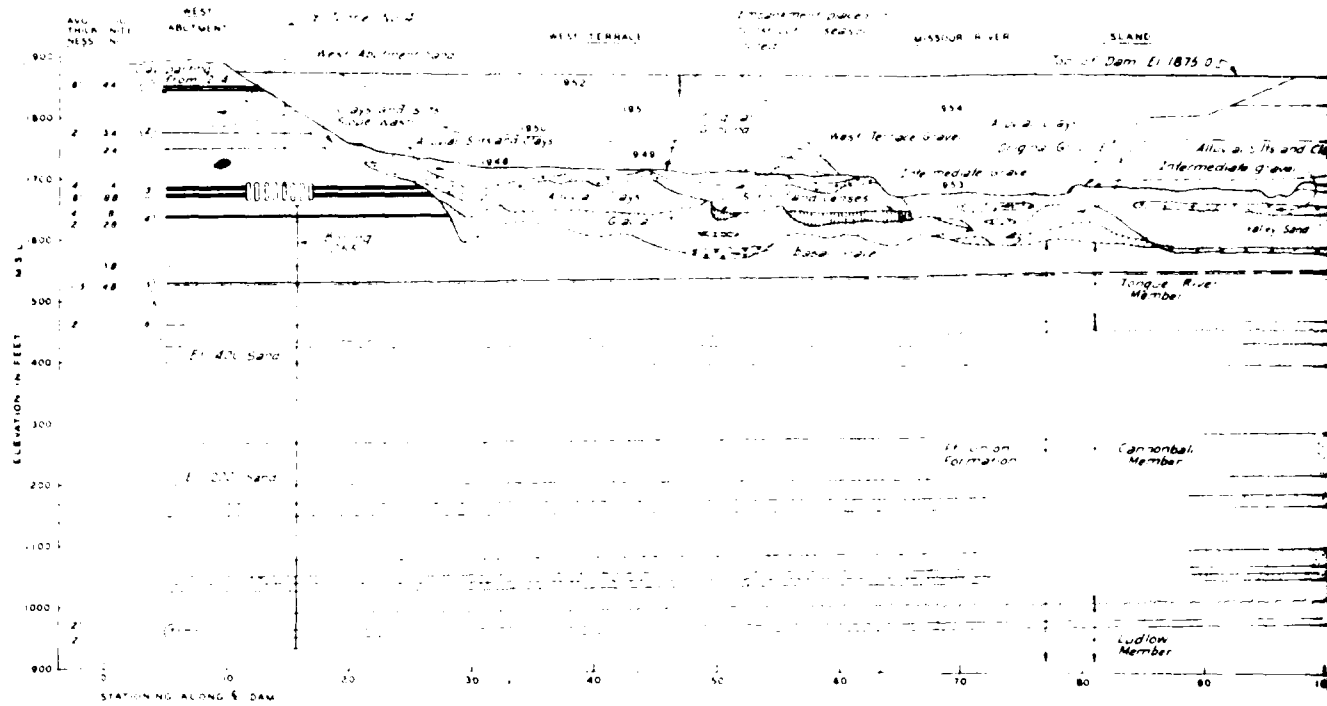
**NOTES**  
 For Plans and Sections of East Abutment  
 see Orig No GE 10-5/9  
 For Legend see Orig No GE 10-5/1  
 For additional borings see Orig Nos GE 10-5/9 & 5/1

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR FOUNDATION EXPLORATIONS EAST ABUTMENT DETACHED BORINGS	
DATE AUGUST 1951	BY GE 10-5/10





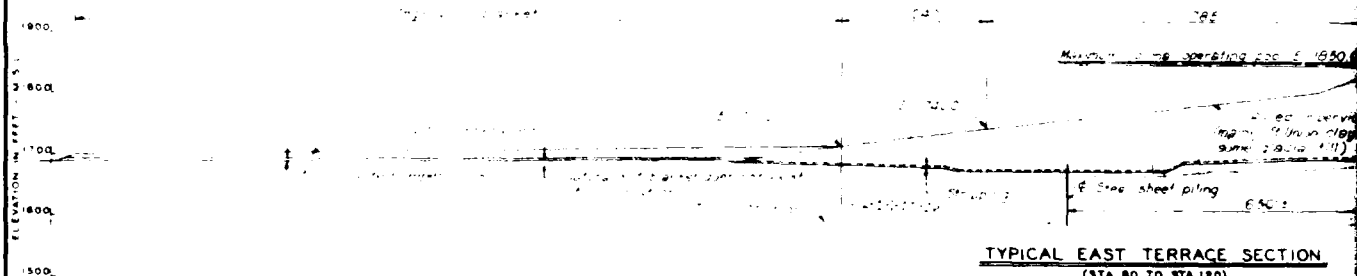
CORPS OF ENGINEERS



LONGITUDINAL PROFILE - E DAM

LOOKING UPSTREAM

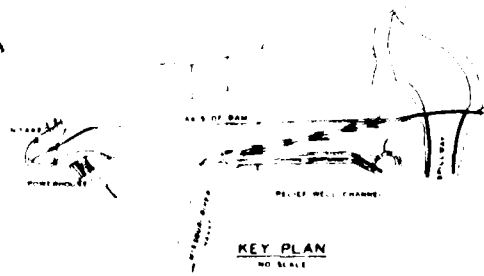
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TYPICAL EAST TERRACE SECTION

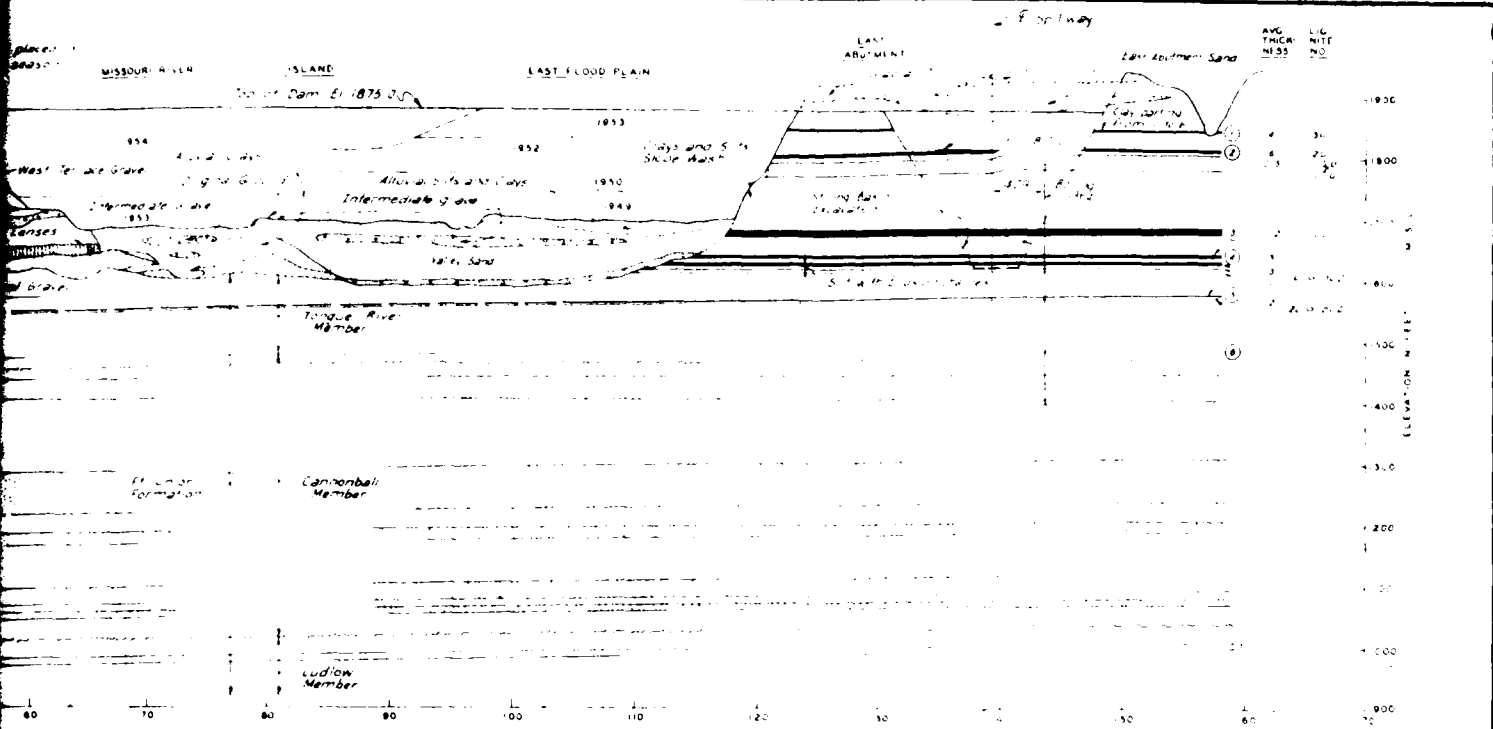
(STA 80 TO STA 120)

SCALE: 1 INCH = 100 FEET  
100 0 100



KEY PLAN

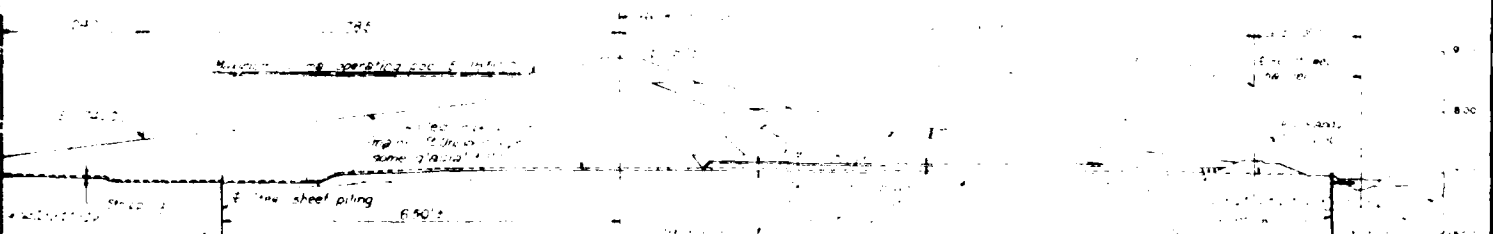
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LONGITUDINAL PROFILE - E DAM

## LOOKING UPSTREAM

SCALE: HOR 1 IN = 500 FT  
VERT 1 IN = 100 FT



TYPICAL EAST TERRACE SECTION

(STA 80 TO STA.120)

SCALE 1 INCH = 100 FEET

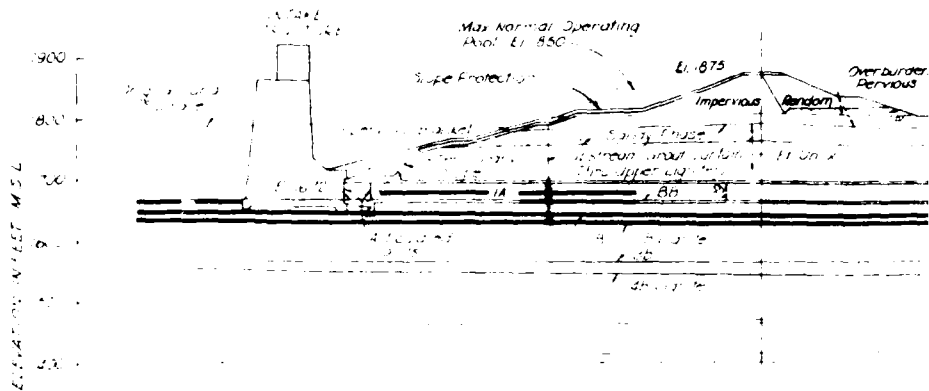


THIS PLAN ACCOMPANIES CONTRACT NO. DA 29 066 MODIFICATION NO.

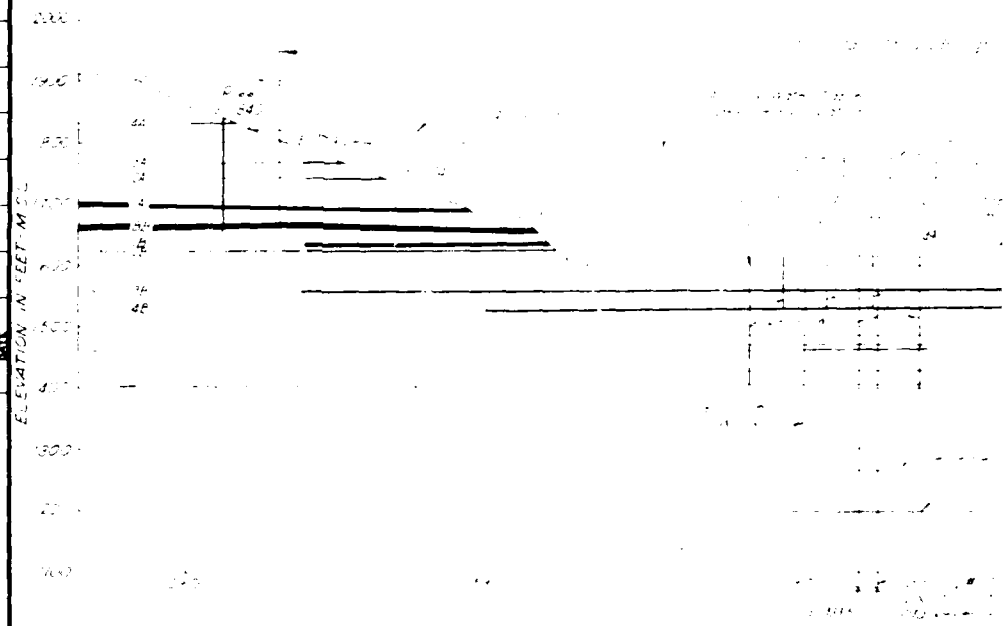
DATE	DESCRIPTION	PLACE
	SEE COVER	
<p align="center"><b>U. S. ARMY ENGINEER DISTRICT, OMAHA</b>  <b>CORPS OF ENGINEERS</b>  <b>OMAHA, NEBRASKA</b></p>		
DRAWN BY CHECKED BY DESIGNED BY INCHES BY NUMBER OF SHEETS APPROVED BY CHECKED BY APPROVED	M. S. S. R. R. R. <p align="center"><b>GARRISON DAM AND RESERVOIR</b>  <b>UNDERSEEPAGE STUDIES</b>  <b>GENERALIZED GEOLOGIC PROFILE</b>  <b>AND SECTION</b></p> <p align="center"><i>See Cover</i></p>	MAY 1964 SCALE AS SHOWN DRAWING NUMBER



## CORPS OF ENGINEERS



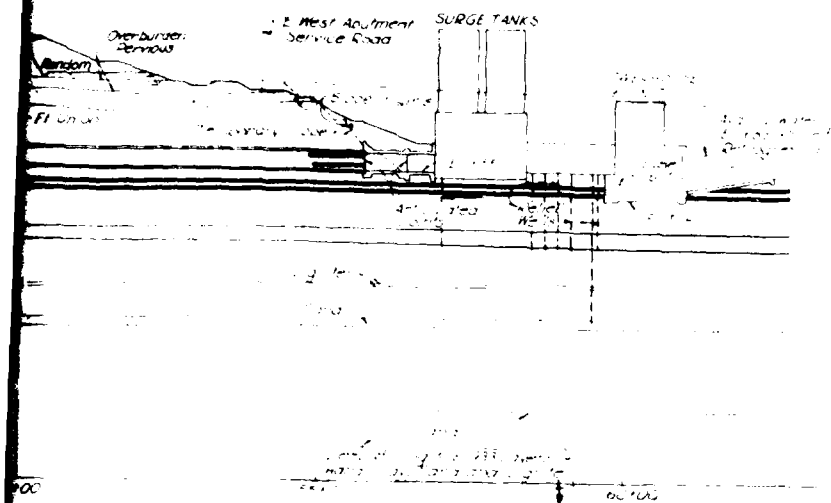
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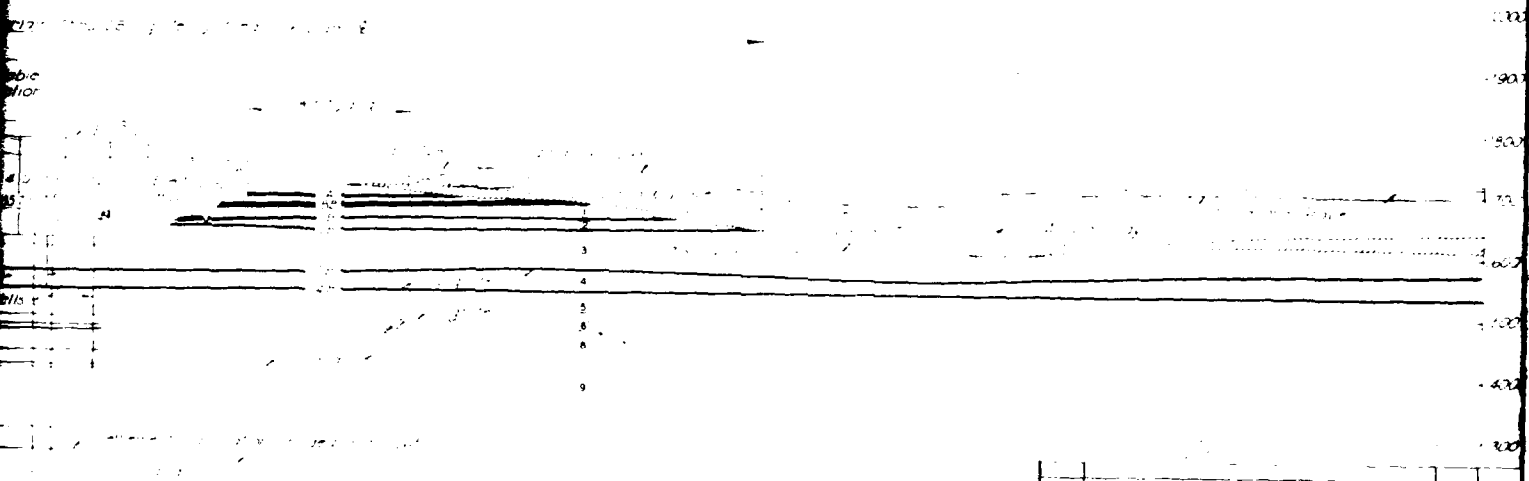
GEOLOGIC SECTION AT STA 1  
UNITS LOOKING NORTH  
SCALE 1 INCH = 100 FEET

A PAPER REPRODUCIBLE "RECORD COPY" MUST BE MADE BEFORE EVERY AGENDA AND / OR MODIFICATION

ADISE HQA NO	
DATE	
ADISE KATION	



**PILE AND OUTLET WORKS**



**SECTION AT STA 159+75**  
 UNIT'S LOOKING NORTH  
 SCALE: 1 INCH = 100 FEET

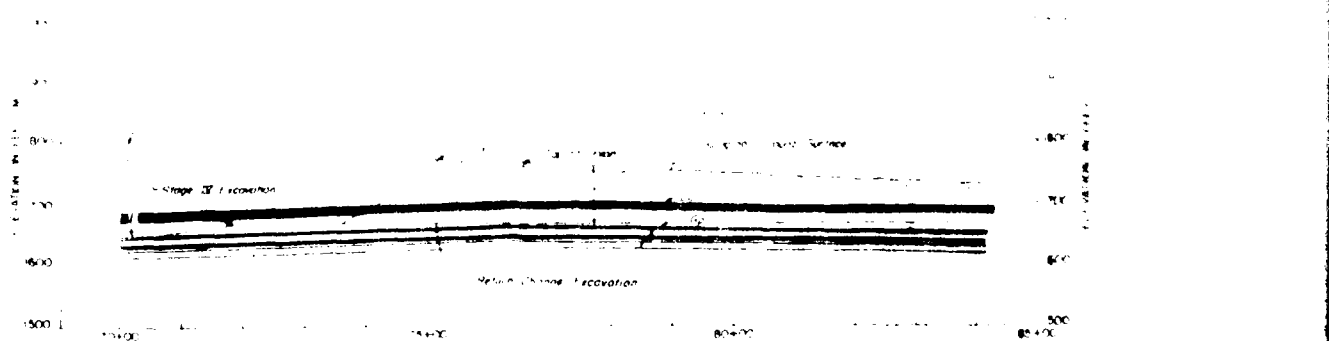
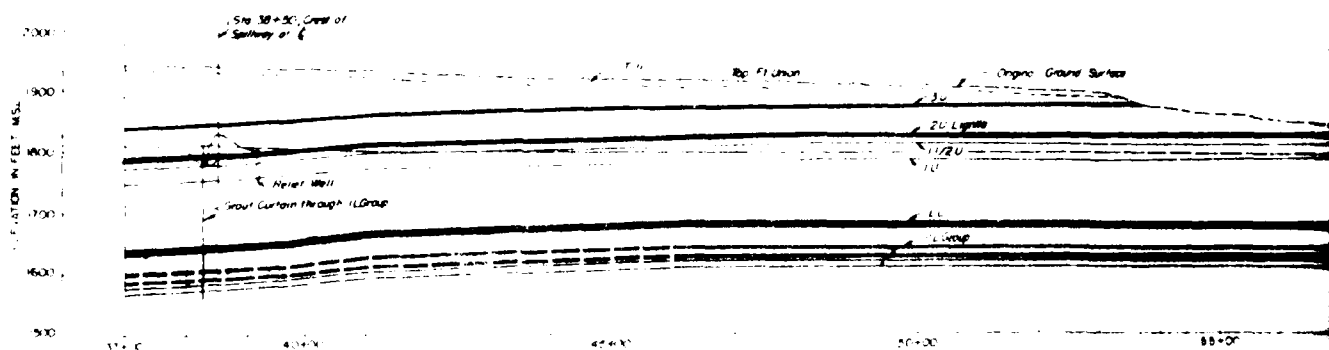
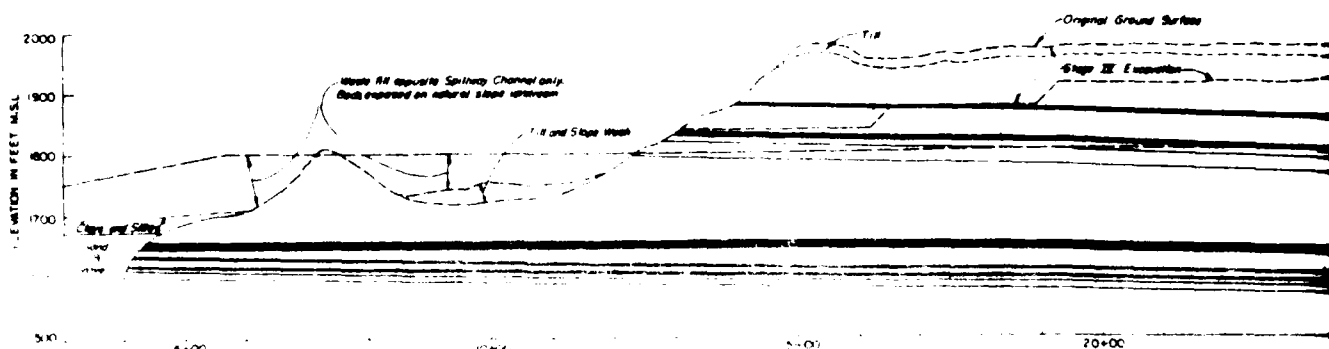
**GENERAL NOTES**

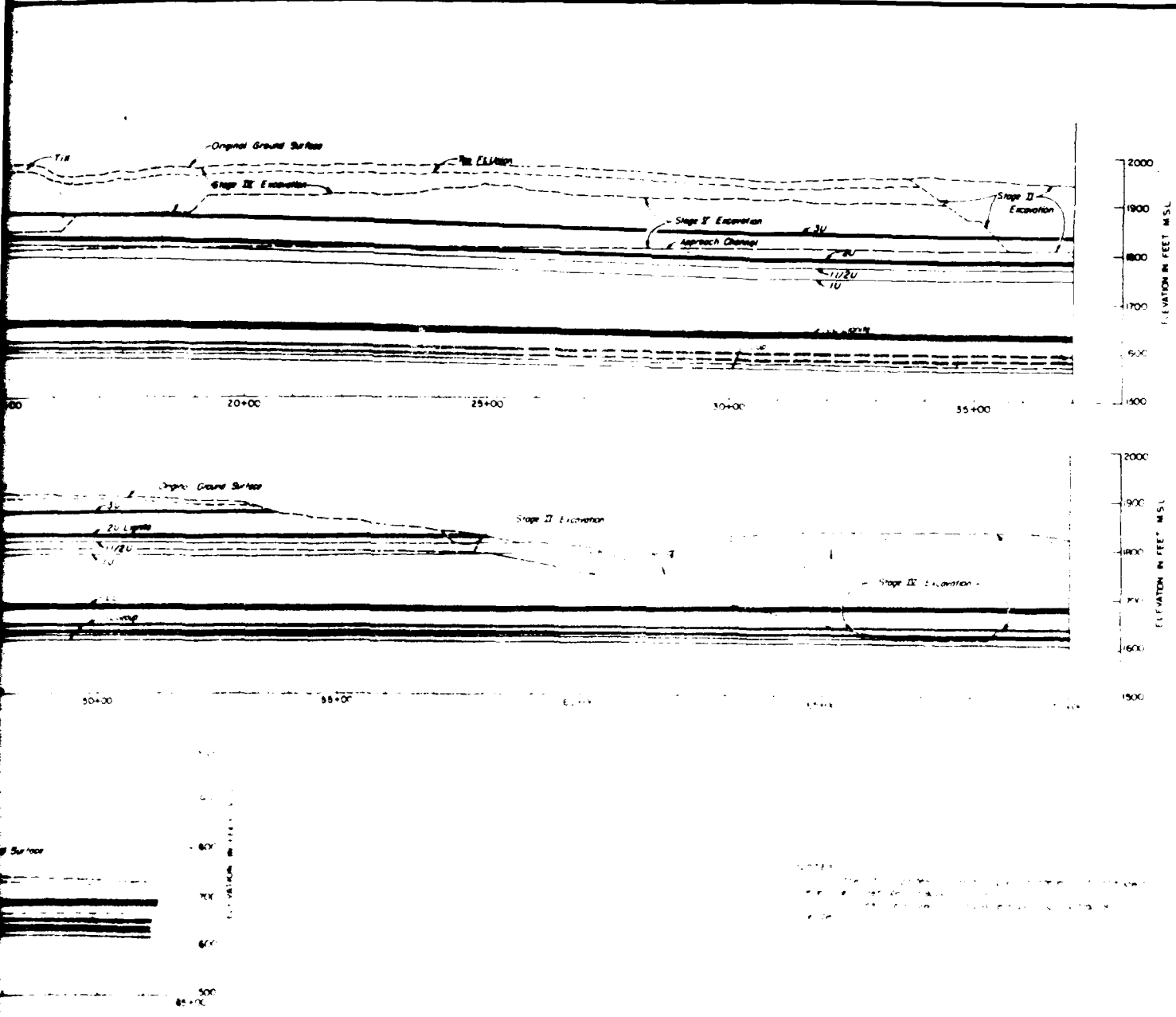
- 1. All construction shall be in accordance with the latest edition of the U.S. Army Corps of Engineers Manual of Practice for the Construction of Outlet Works.
- 2. The geologic profile shown on this plan is based on the results of the geologic investigation conducted by the Corps of Engineers.
- 3. The outlet works structure shall be designed to withstand the maximum flood discharge of the reservoir.
- 4. The surge tanks shall be constructed of reinforced concrete.
- 5. The foundation for the outlet works shall be founded on the bedrock.



THIS PLAN ACCOMPANIES CONTRACT NO. DA-28-066-46 MODIFICATION NO. 1

DATE		REVISION		NAME		GRADE	
<p align="center"><b>U. S. ARMY ENGINEER DISTRICT, OMAHA</b>  <b>CORPS OF ENGINEERS</b>  <b>OMAHA, NEBRASKA</b></p>							
DESIGNED BY: OMA		CHECKED BY: OMA		APPROVED BY: OMA		DATE: MAY 1982	
<p align="center"><b>GARRISON DAM AND RESERVOIR</b>  <b>UNDERSEEPAGE STUDIES</b>  <b>GEOLOGIC PROFILE OF OUTLET WORKS AND</b>  <b>GEOLOGIC SECTION THRU POWERHOUSE</b></p>				<p align="center"><i>Charles F. Kopp</i>                  DISTRICT ENGINEER</p>		<p align="center"><i>Donald L. Fair</i>                  DISTRICT ENGINEER</p>	
SCALE: AS SHOWN		SHEET NO. 41 OF 44		PROJECT NO.		DRAWING NO.	

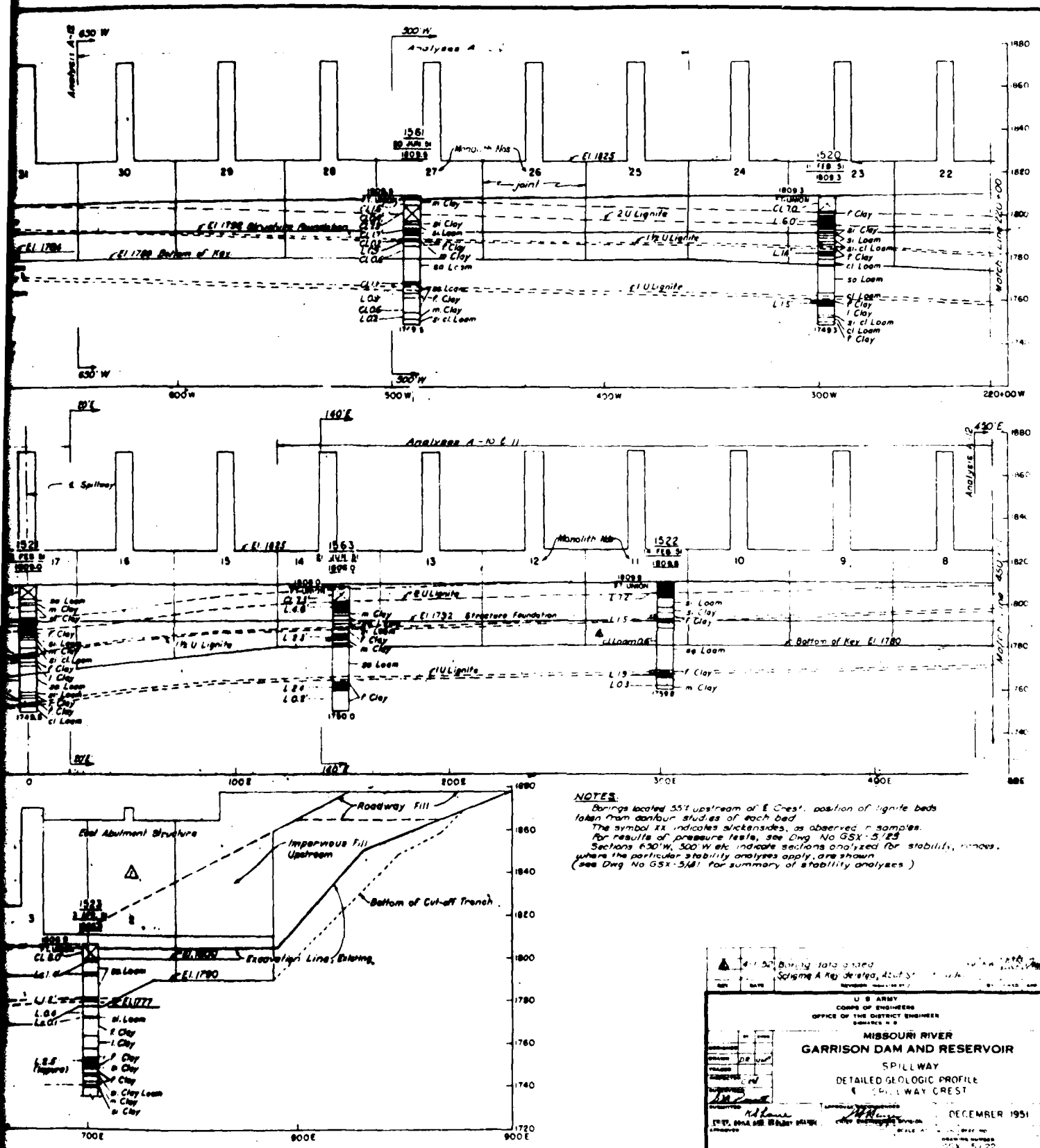




REV.	DATE	REVISIONS
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY GENERALIZED GEOLOGIC PROFILE CENTERLINE OF CHANNEL DECEMBER 1951 GSK-5/21		

2

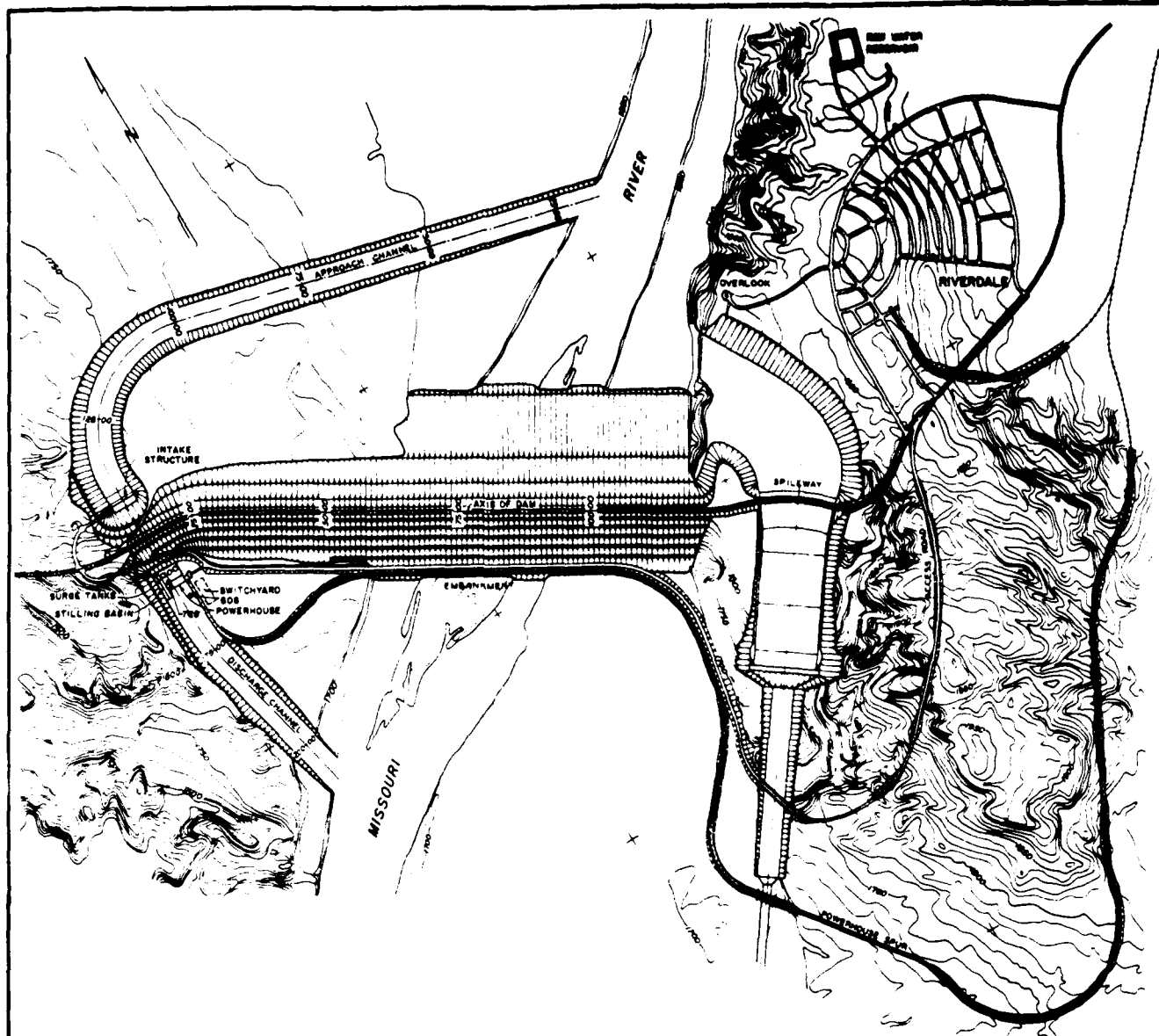




CONSTRUCTION FOUNDATION REPORT

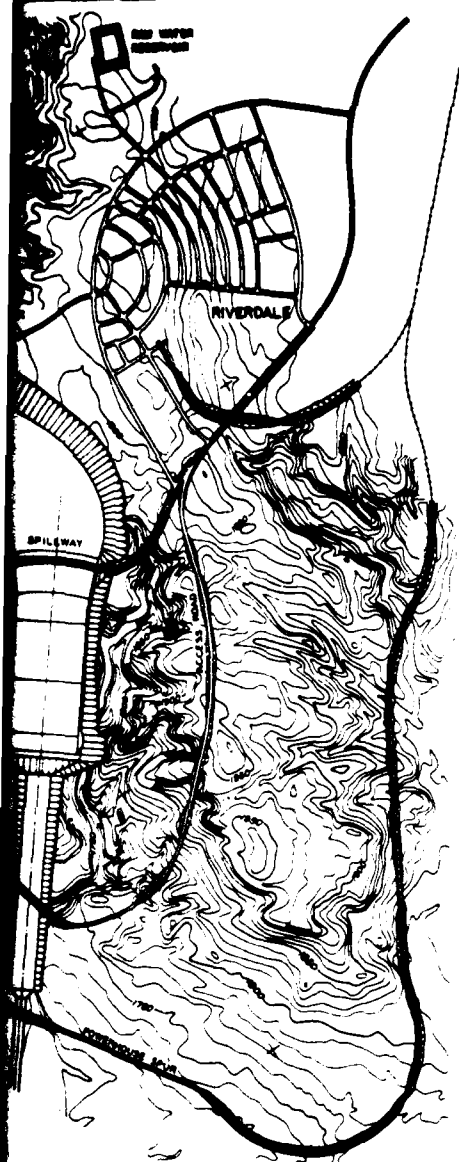
(1982)

PLATE 43



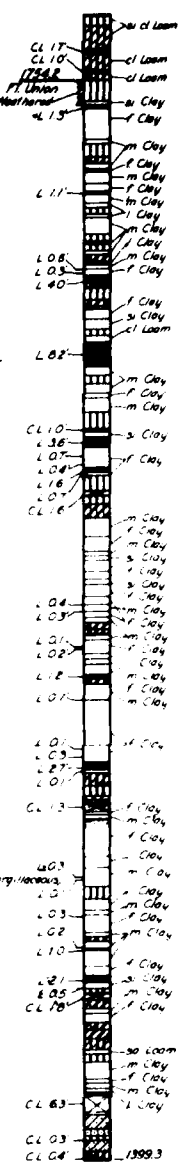
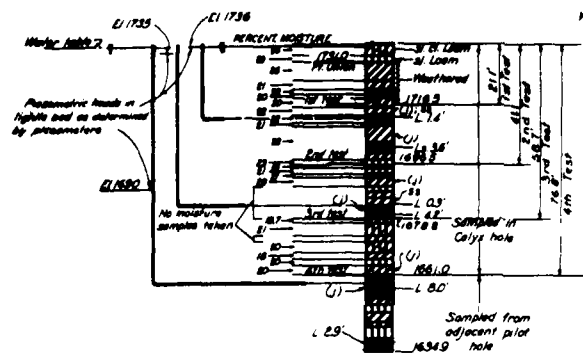
PLAN

Scale 1" = 1000'

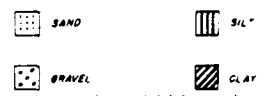


608  
30 MAR 47  
1773.8

780  
3 SEPT 47  
1773.8



**GRAIN SIZE SYMBOLS**

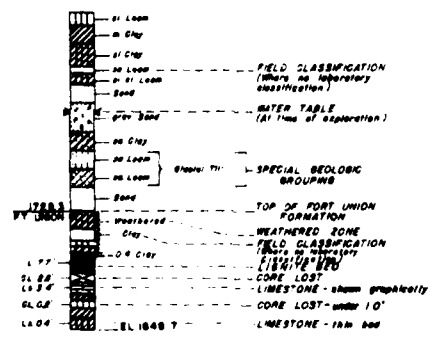


Symbols represent grain size distribution, predominant types by heavy lines, modifying types by light lines

**OTHER SYMBOLS**



87 --- HOLE NUMBER  
28 MAR 43 --- DATE HOLE COMPLETED  
1788.4 --- ELEV TOP OF HOLE

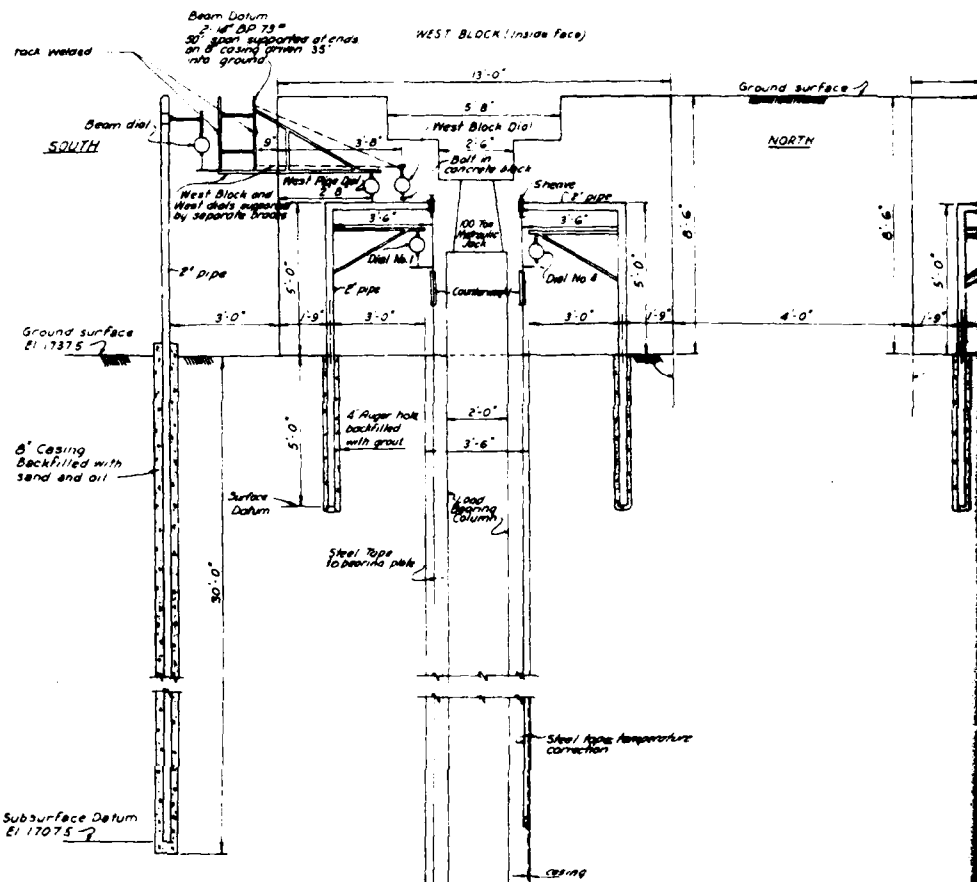


grv — gravelly  
sa — sandy  
si — silty  
cl — clayey

Lean, medium & fat clays are not differentiated in Fort Union  
Fine, medium & coarse sands are not differentiated in both overburden and Fort Union, strata less than 10' thick not shown, being combined with the most similar material above or below except thicknesses of 0.1' are indicated for lignite, limestone, core lost, and foreign material within a salvageable lignite bed

KEY	DATE	REVISION (Indicated by 1)	BY
CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER BISMARCK, N.D.			
MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR</b> <b>SOIL PROFILE &amp; LOCATION OF</b> <b>BEARING TEST HOLE NO. 608</b>			
COMPILED BY J. D. A.	DESIGNED BY J. D. A.	CHECKED BY J. D. A.	
DATE December 1947		SCALE AS SHOWN DRAWING NUMBER SDR-5/1	





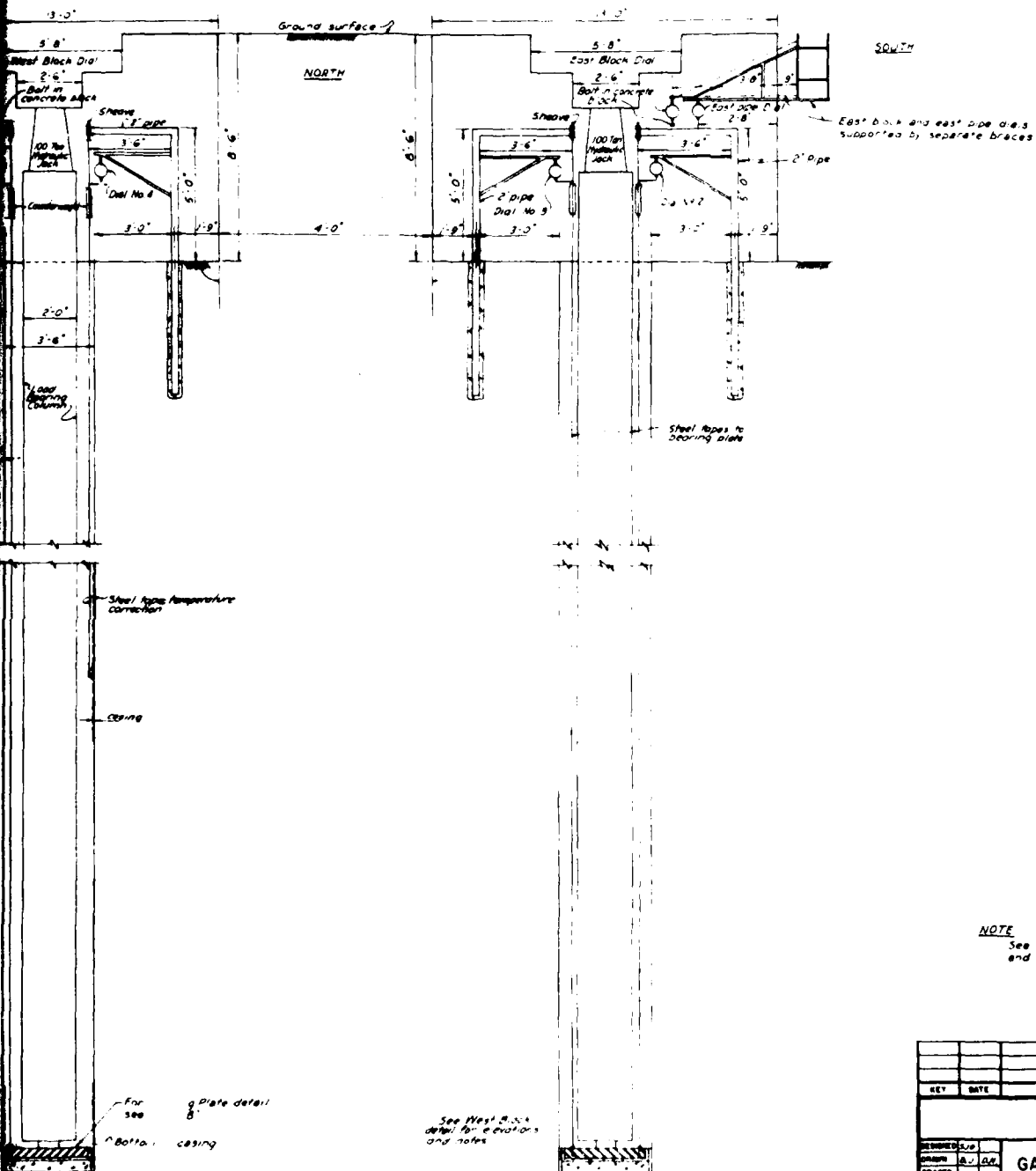
Test No	Elev
1	1716.5
2	696.4
3	1678.8
4	660.7

For see 8" plate detail  
Bottom casing

See detail on one side

WEST BLOCK (inside face)

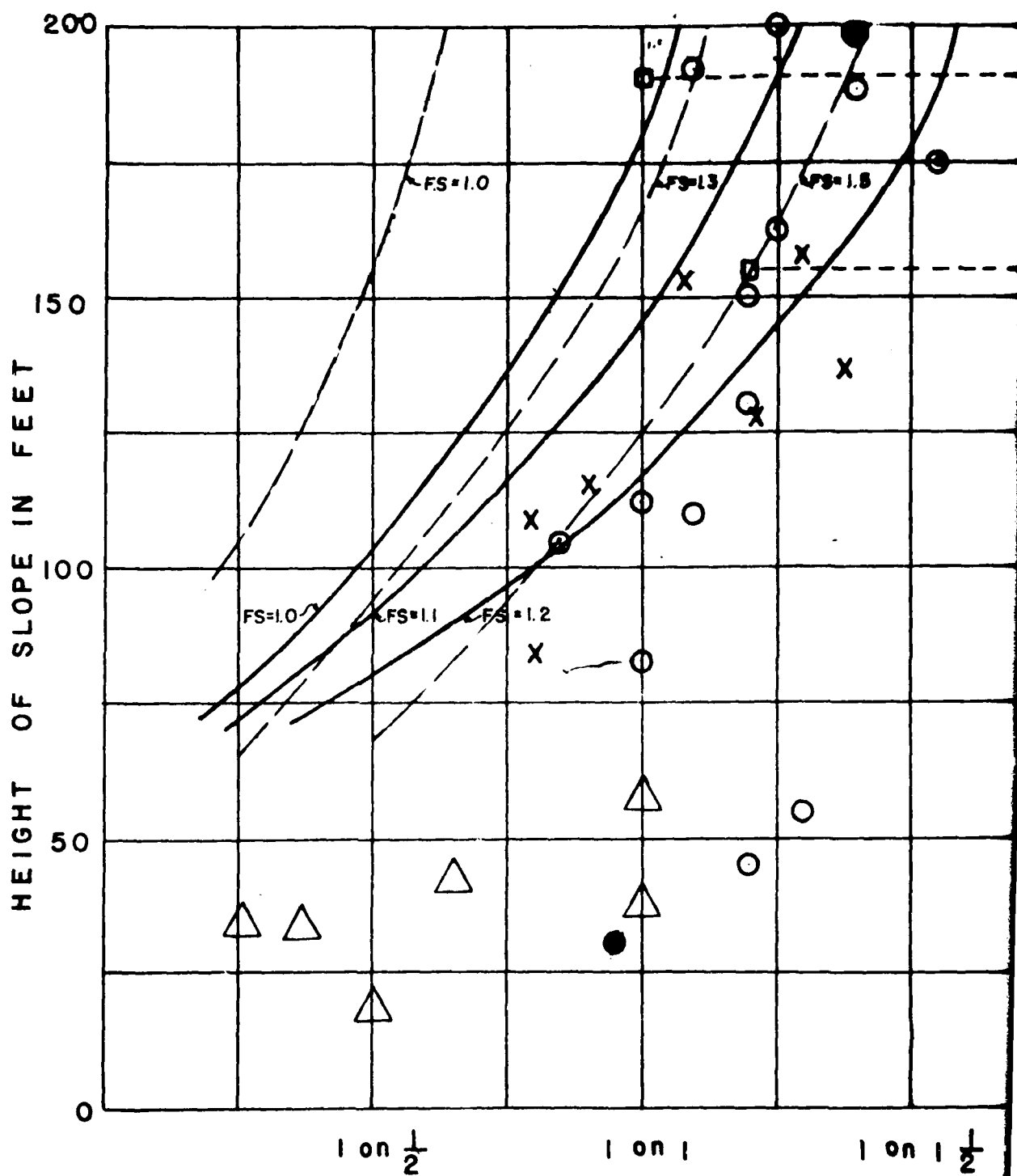
EAST BLOCK (inside face)

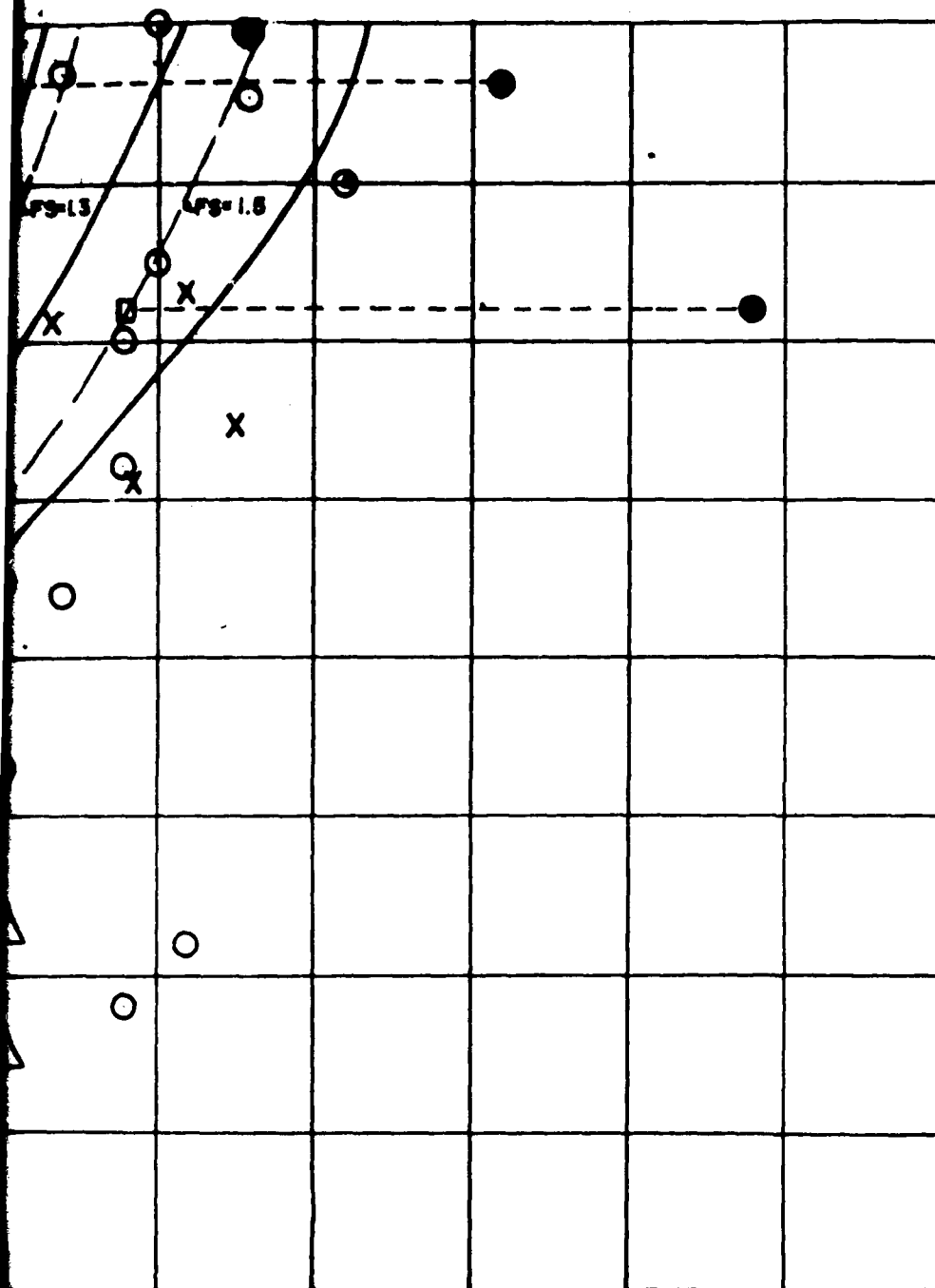


**NOTE**

See "Plate B" for construction drawing and other details

KEY	DATE	REVISION (initialed by)	BY
WAR DEPARTMENT CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.			
MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR</b> LOAD BEARING TEST IN 42" DIA HOLE 608 - DIAL & DATUM LOCATIONS			
DESIGNED BY	CHIEF	DATE	DEC 1947
TRACED	BY	DATE	
CHECKED	BY	DATE	
APPROVED	BY	DATE	
SCALE 1" = 10'		SPEC NO.	
DRAWING NUMBER		341-525	
SHEET		OF	





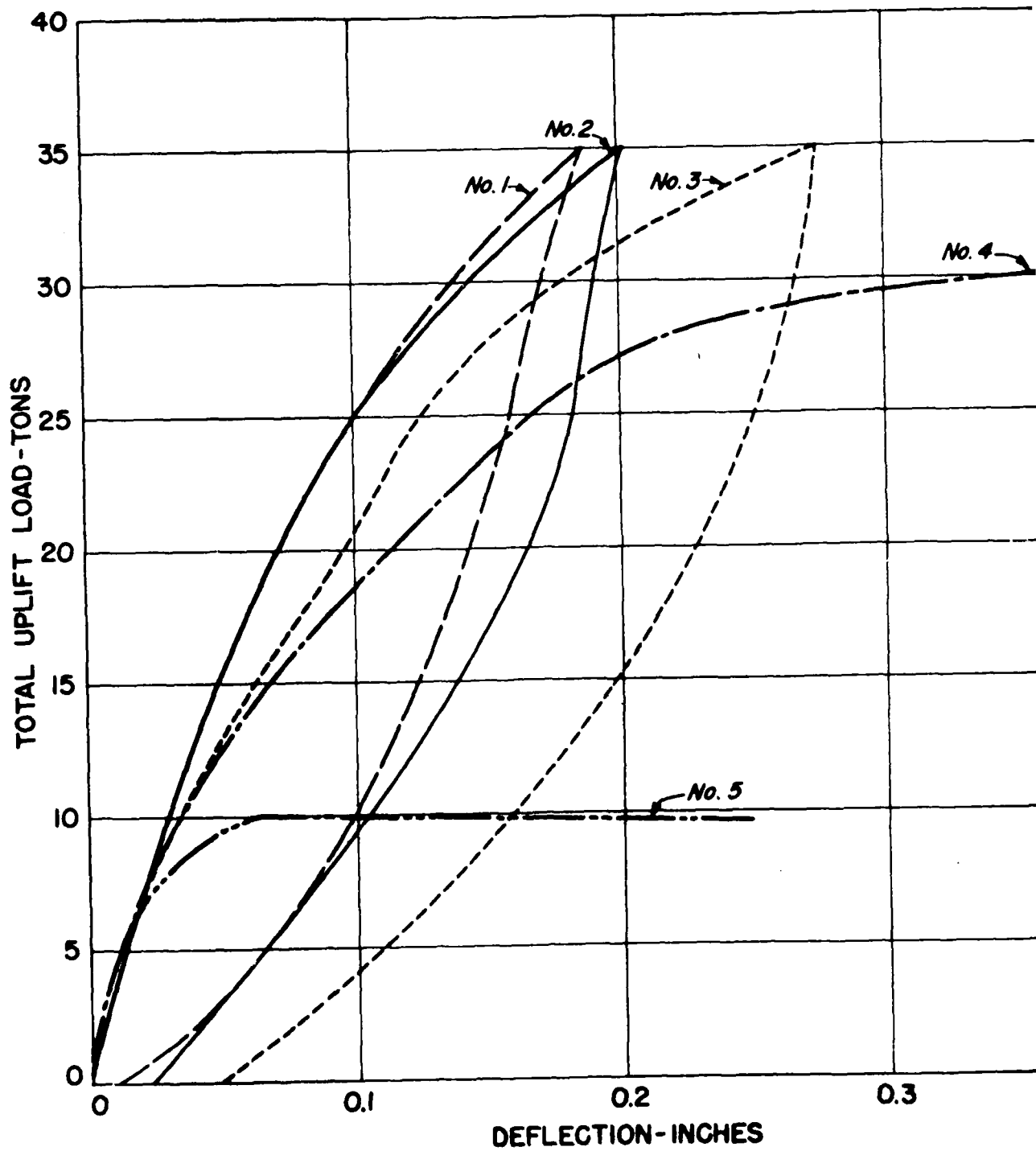
# **LEGEND**

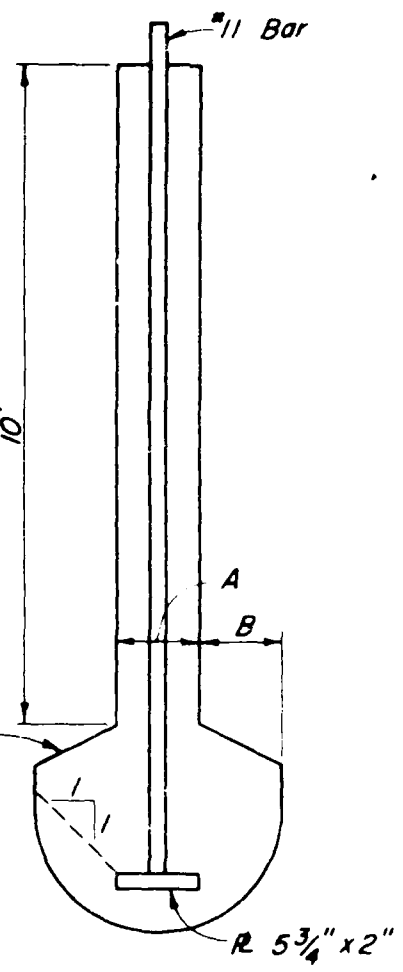
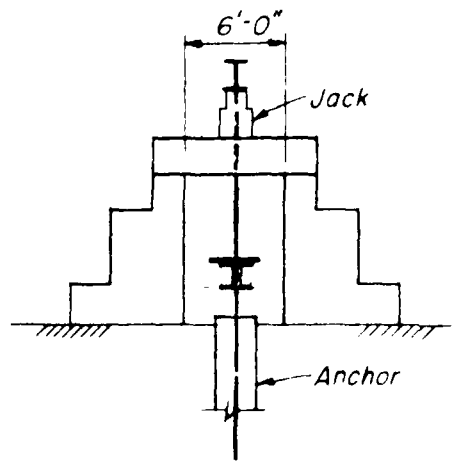
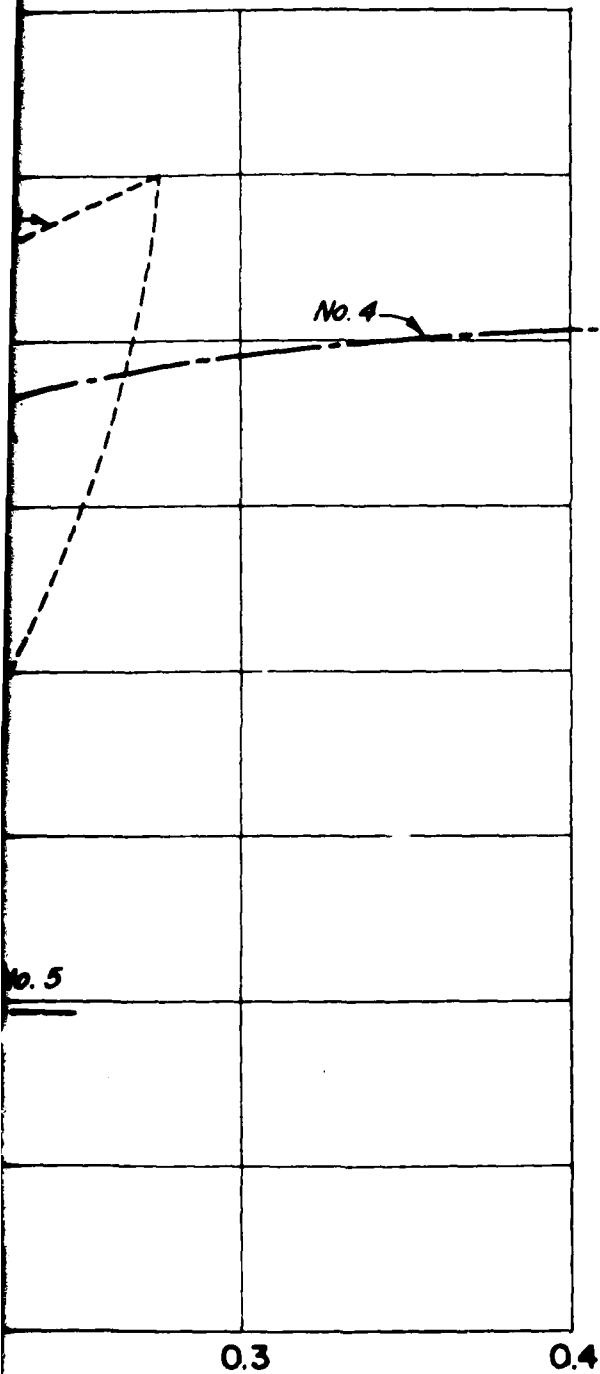
- X TEMPORARY EXCAVATED SLOPES IN POWERHOUSE AREA
- SLOPE MEASURED AFTER FAILURE
- SLOPE AS MEASURED
- PROBABLE CONDITION OF SLOPE BEFORE FAILURE
- △ APPROXIMATE SLOPES OBSERVED IN LIGNITE STRIP MINES AND RAILROAD CUTS
- FS FACTOR OF SAFETY
- COHESION 0.70 T/SQ.FT.  $\phi$  20°
- COHESION 0.70 T/SQ.FT.  $\phi$  30°

GARRISON RESERVOIR  
MISSOURI RIVER BASIN  
NORTH DAKOTA

ANALYTICAL STUDIES  
OF FIELD SLOPES  
IN FT. UNION  
U.S. ENGINEER OFFICE, BISMARCK, N. DAK.

Dwg. No. GEX 7/2





Sufficient slope to prevent voids between earth and concrete

SYMBOL	CURVE NO.	A In.	B In.
—————	1	8	12
—————	2	6	9
- - - - -	3	6	6
- . - . -	4	6	3
- . . . -	5	6	0

# ANCHOR TEST DATA

Design Memorandum No. 1

PLATE IV-4

AD-A140 035

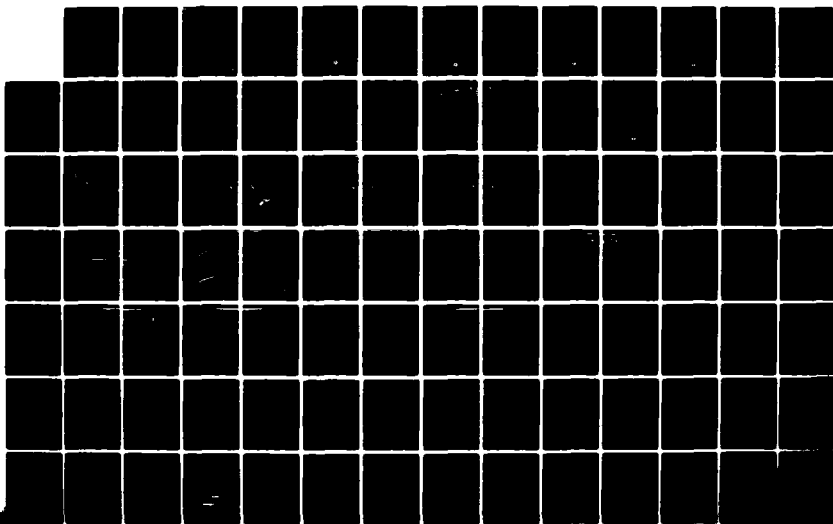
CONSTRUCTION FOUNDATION REPORT MISSOURI RIVER GARRISON  
DAM LAKE SAKAKAWEA VOLUME 2 DRAWINGS(U) ARMY ENGINEER  
DISTRICT OMAHA NE NOV 83

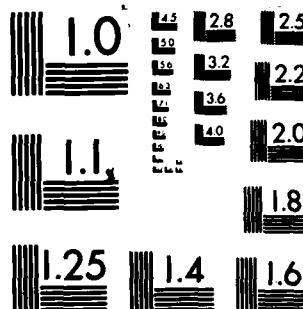
24

UNCLASSIFIED

F/G 13/13

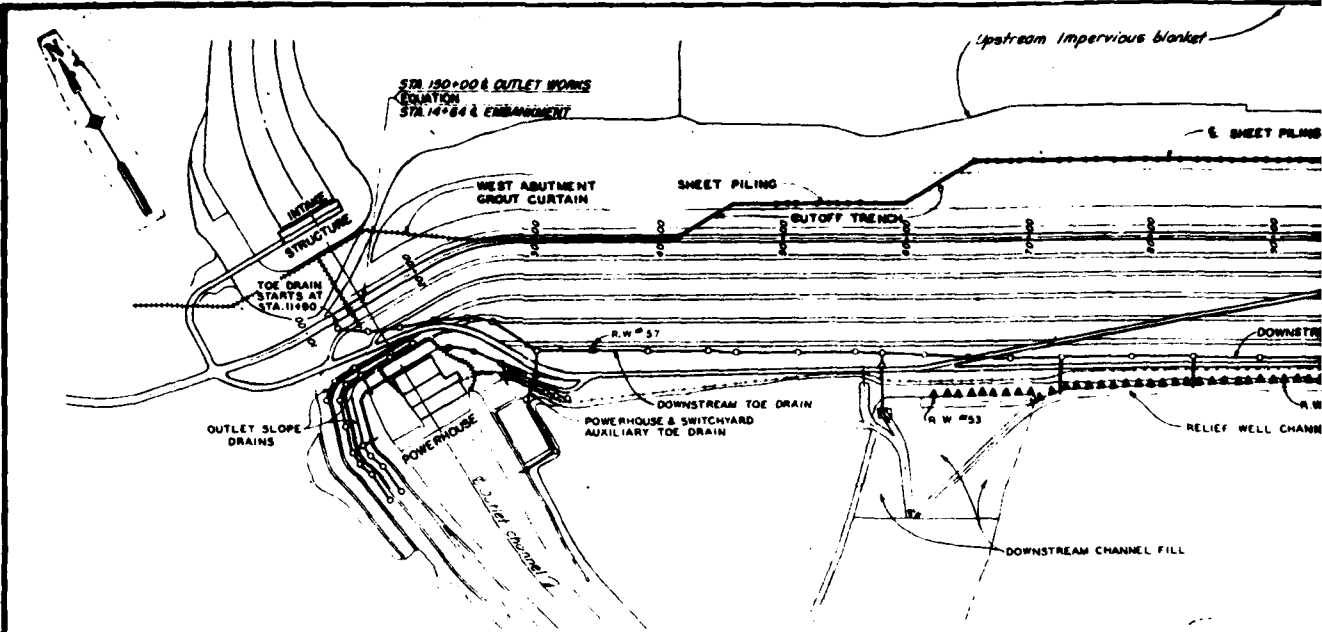
NL





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

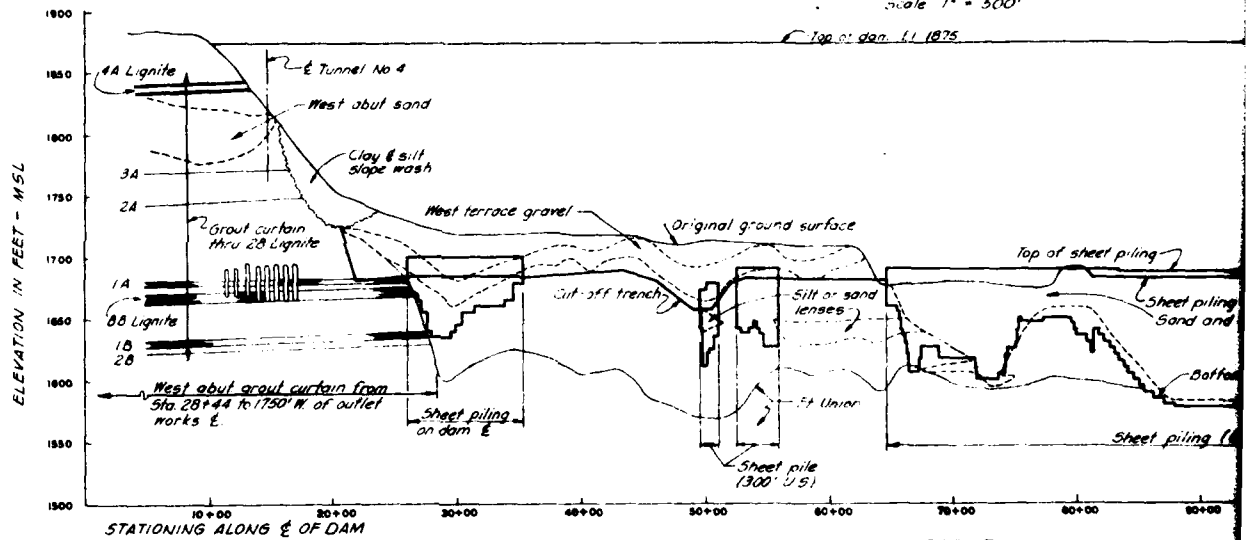




PLAN

Scale: 1" = 500'

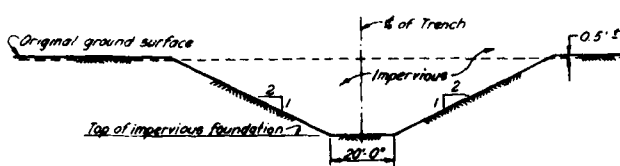
Top of dam: 11.1075



PROFILE

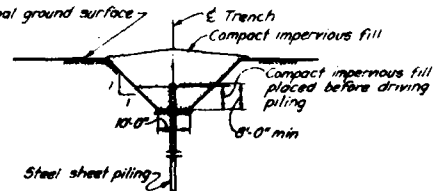
(ALONG SHEET PILING, CUTOFF TRENCH & GROUT CURTAIN)

Vert. 1" = 50'  
Horiz. 1" = 500'



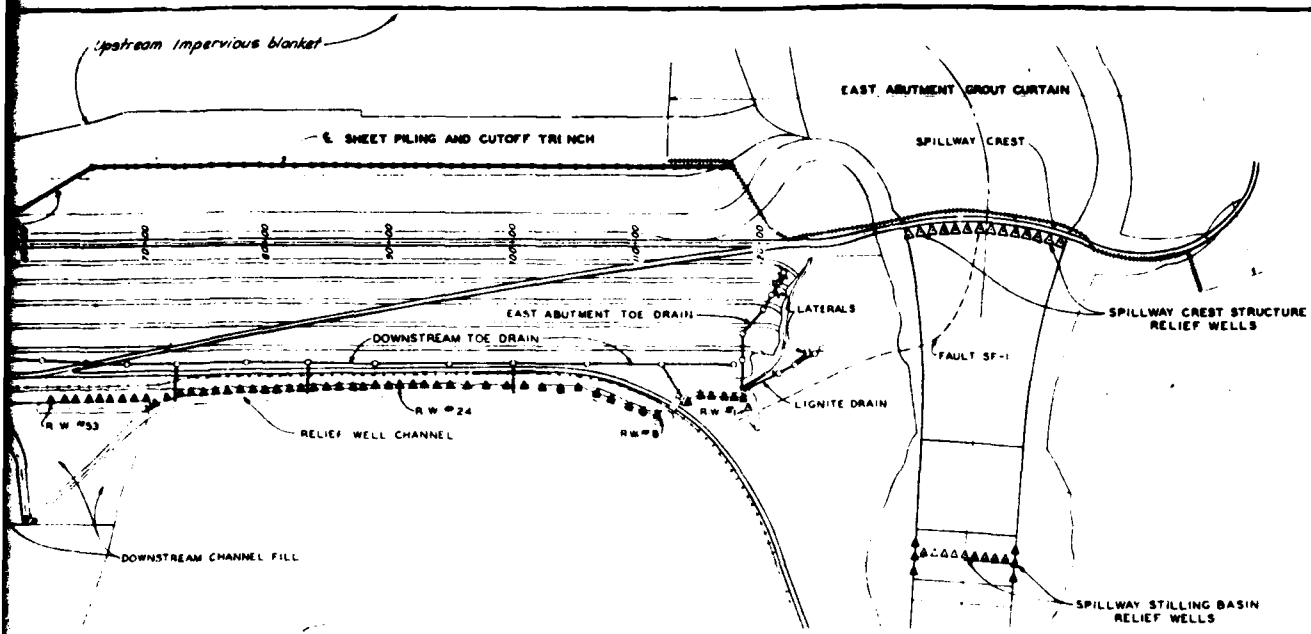
TYPICAL SECTION THRU CUTOFF TRENCH

Scale: 1" = 20'



TYPICAL SECTION THRU SHEET PILING TRENCH

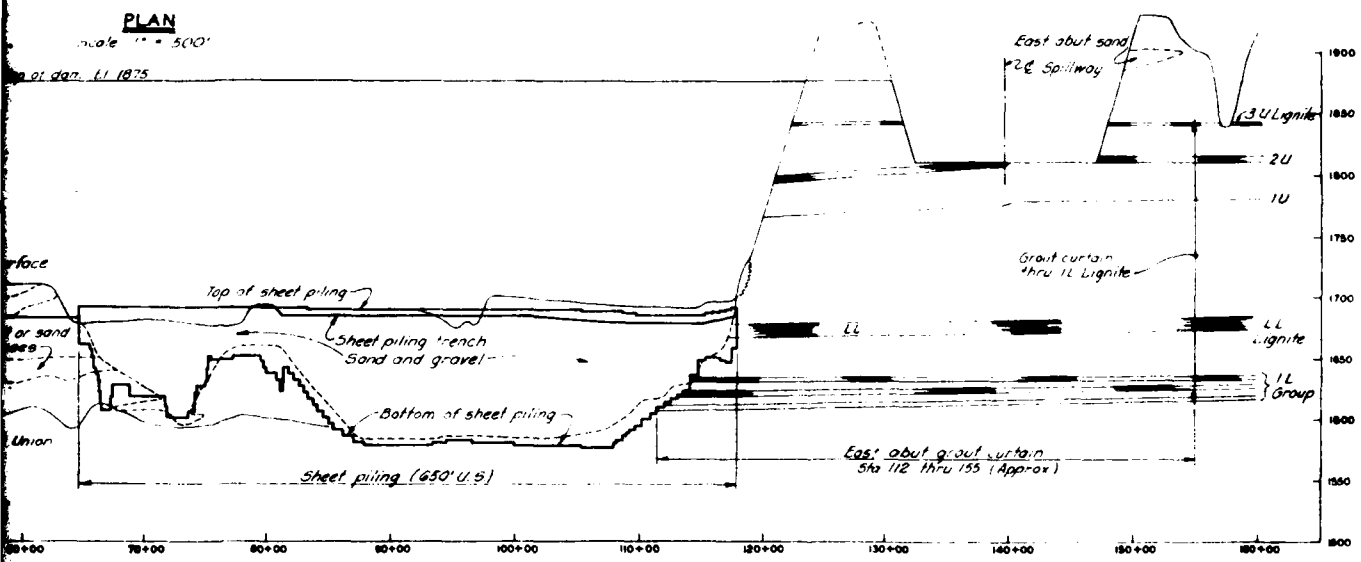
Scale: 1" = 20'



**PLAN**

Scale 1" = 500'

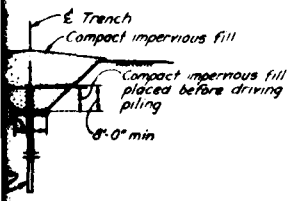
at dam, LI 1875



**PROFILE**

SHEET PILING, CUT-OFF TRENCH & GROUT CURTAIN

Scales: Vert. 1" = 50'  
Horiz. 1" = 500'



**SECTION THRU  
PILING TRENCH**

Scale: 1" = 20'

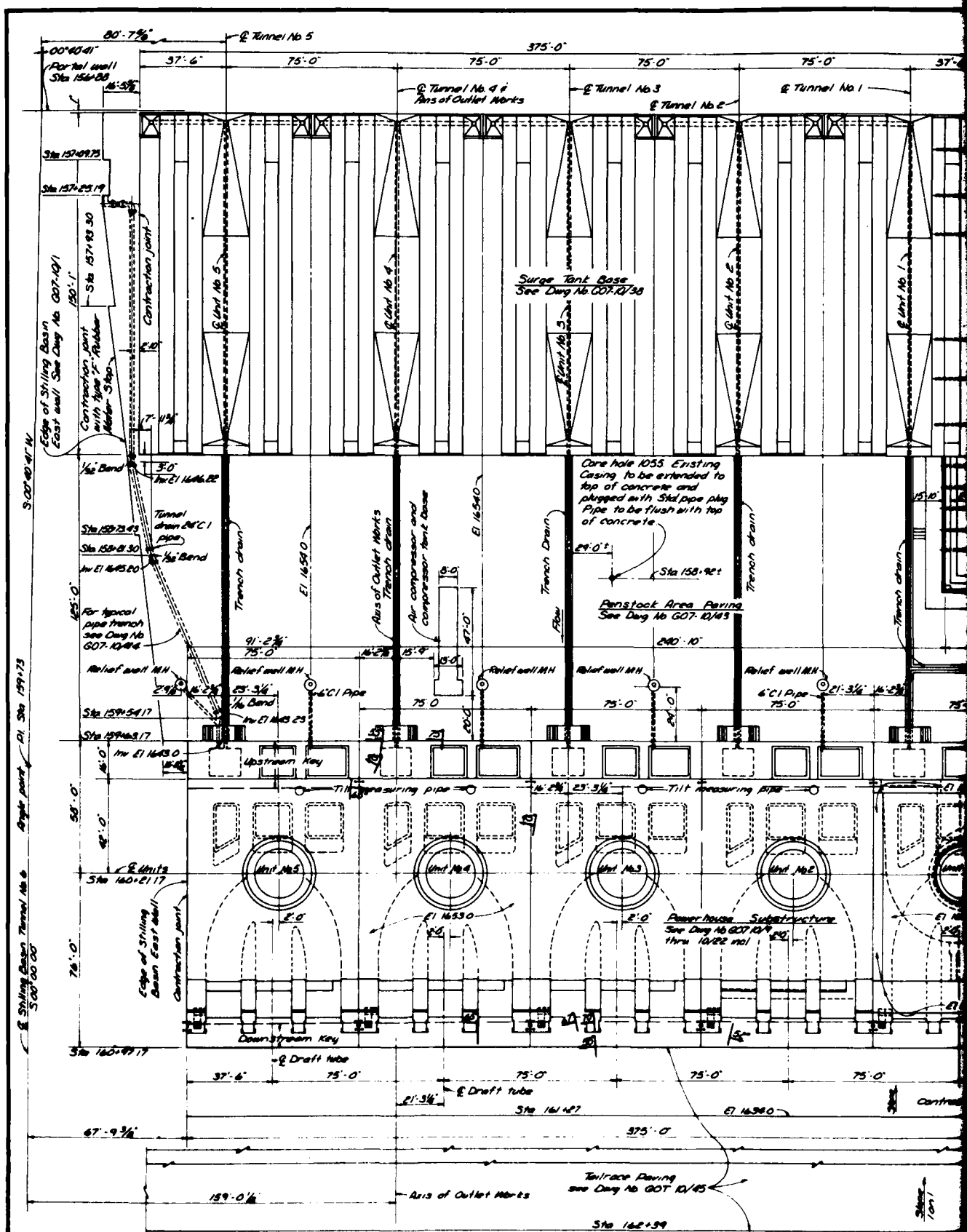
THIS DRAWING HAS BEEN REDUCED TO  
THREE EIGHTHS THE ORIGINAL SCALE

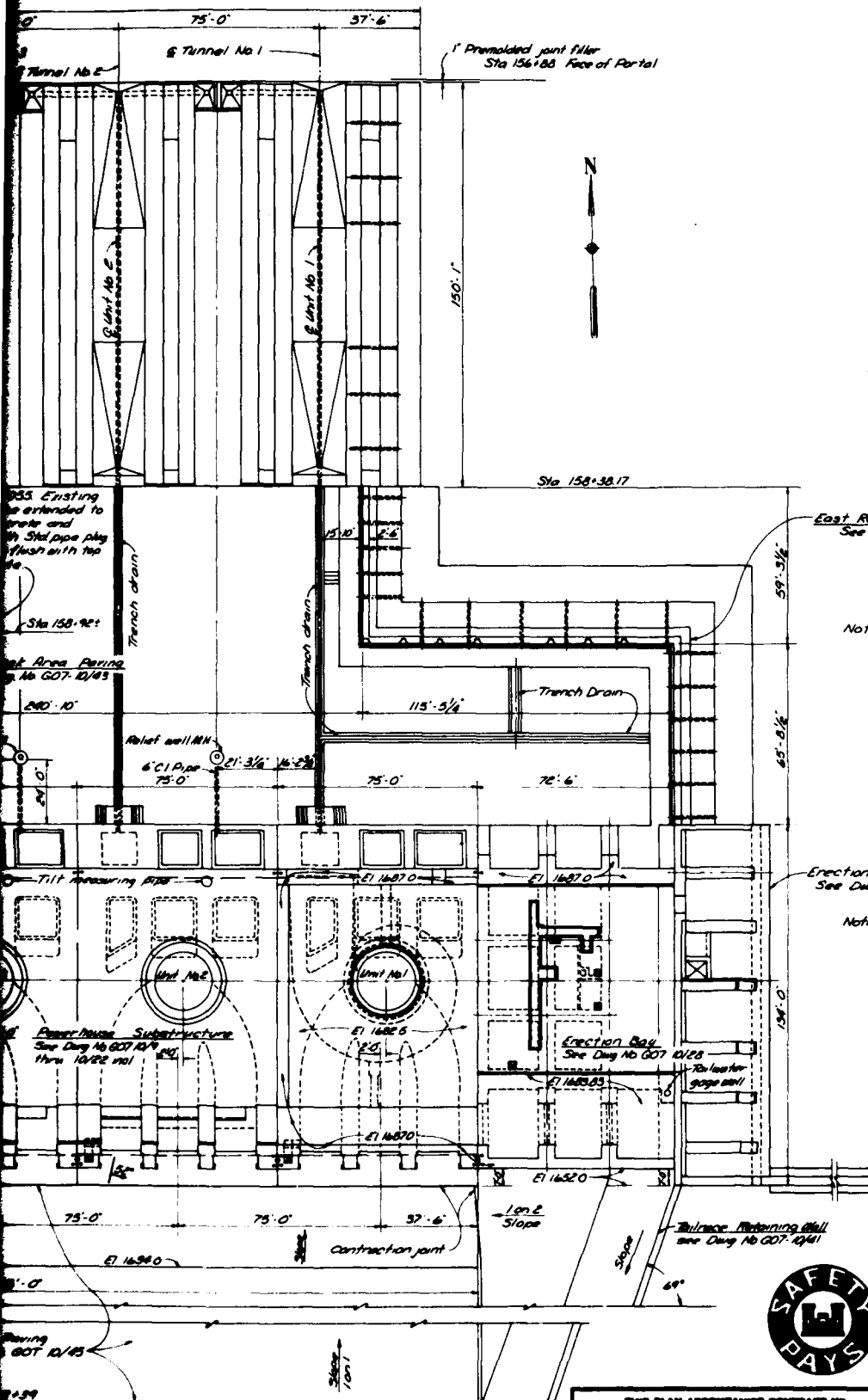


THIS PLAN ACCOMPANIES CONTRACT NO  
DA-24-068-111 MODIFICATION NO

U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA	
MISSOURI RIVER	
GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES SEEPAGE CONTROL	
DESIGNED BY: OWA CHECKED BY: R.W.R. DESIGNED BY: C.V.J. CHECKED BY: R.W.R. APPROVED BY: [Signature] APPROVED BY: [Signature]	APPROVED BY: [Signature] DATE: [Blank] SCALE: [Blank] SHEET NO. [Blank] TOTAL SHEETS [Blank]

2





East Retaining Wall  
See Dwg No G07-10/40

Note  
Strike-Dip Symbol for Faults

Direction  
& Angle of Dip  
Strike of Fault  
(Bearing)

Erection Bay - East Wall  
See Dwg No's G07-10/31 and 10/32

Notes  
For General Plan see Dwg No G07-2/3  
For General Plan - Stilling Basin and Powerhouse  
Substructure, see Dwg No G07-2/4  
For Stilling Basin - Plan, see Dwg No G07-10/1  
For Layout and Alignment, see Dwg No G07-2/6

### PLAN - LOCATION OF OLD FAULTS ENCOUNTERED IN KEY EXCAVATIONS

THIS DRAWING HAS BEEN REDUCED TO  
THREE-EIGHTHS THE ORIGINAL SCALE.



THIS PLAN ACCOMPANIES CONTRACT NO.  
DACA45 MODIFICATION NO.

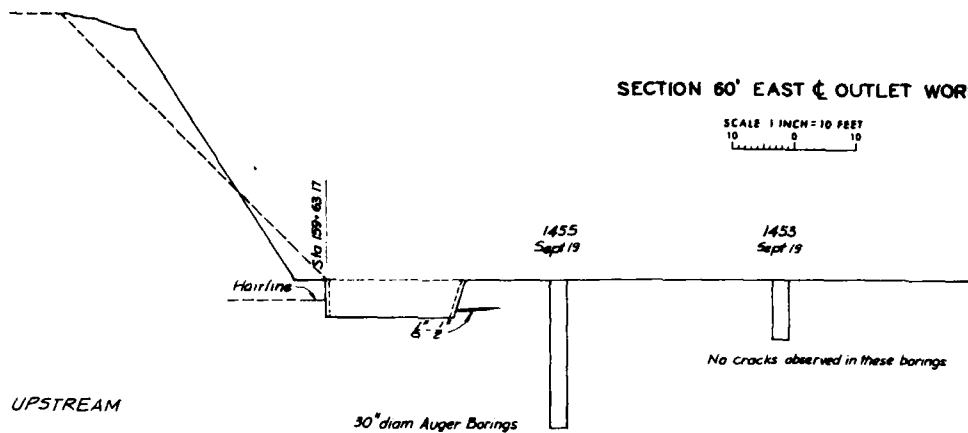
DATE	DESCRIPTION	BY	APPROVED
<b>REVISIONS</b> U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA MISSOURI RIVER <b>GARRISON DAM - LAKE SAKAKAWEA          POWERHOUSE AREA          CONCRETE PLAN          LOCATION OF FAULTS</b>			
DESIGNED BY	CHECKED BY	DATE	BY
PROJECT NO.	SCALE	DATE	BY
CONTRACT NO.	SCALE AS SHOWN	DATE	BY
PROJECT NO.	SCALE AS SHOWN	DATE	BY





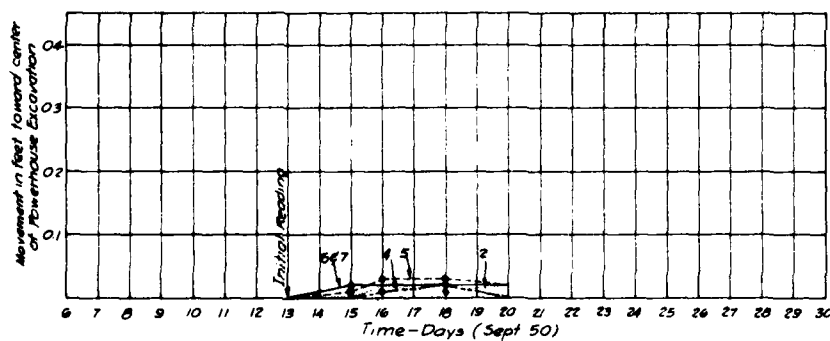
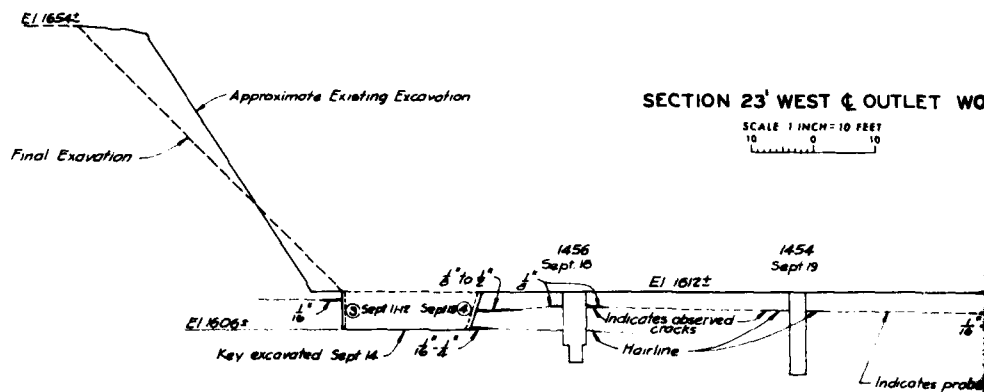
# SECTION 60' EAST OF OUTLET WORK

SCALE 1 INCH = 10 FEET  
10 0 10

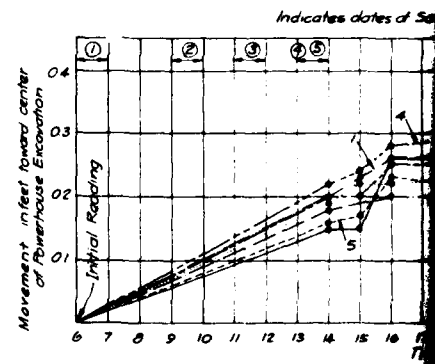


# SECTION 23' WEST OF OUTLET WORK

SCALE 1 INCH = 10 FEET  
10 0 10



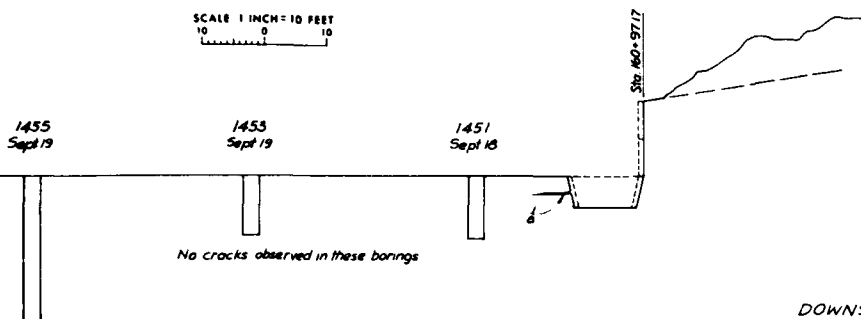
MOVEMENT ALONG STA. 159+63.17



MOVEMENT

# SECTION 60' EAST & OUTLET WORKS

SCALE 1 INCH = 10 FEET

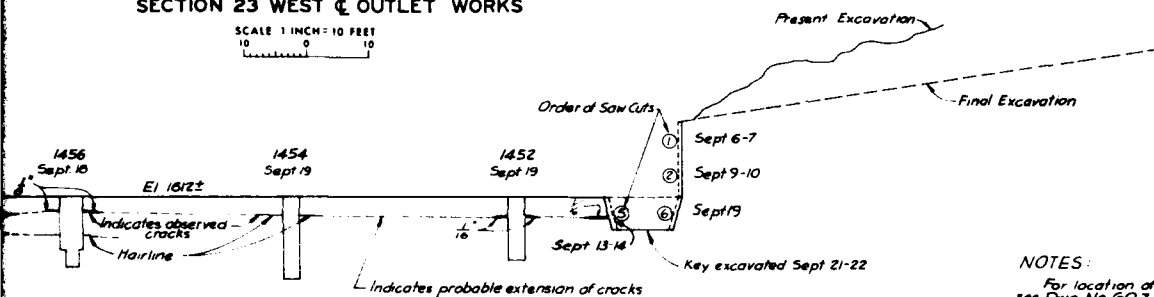


ESTIMATED STRAIN DIAGRAM  
AFTER MAKING SAW CUTS 4 & 5

DOWNSTREAM

# SECTION 23' WEST & OUTLET WORKS

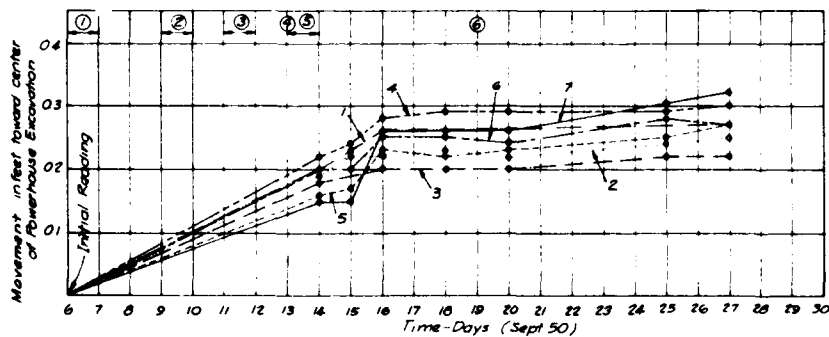
SCALE 1 INCH = 10 FEET



## NOTES:

For location of movement control points 1 thru 7  
see Dwg No G07-4/4 Plate No 1  
For profiles showing cracks along keys see  
Dwg No GPX-6/23

Indicates dates of Saw Cuts



MOVEMENT ALONG STA. 160+97.17

THIS DRAWING HAS BEEN REDUCED TO  
THREE-FOURTHS THE ORIGINAL SCALE.

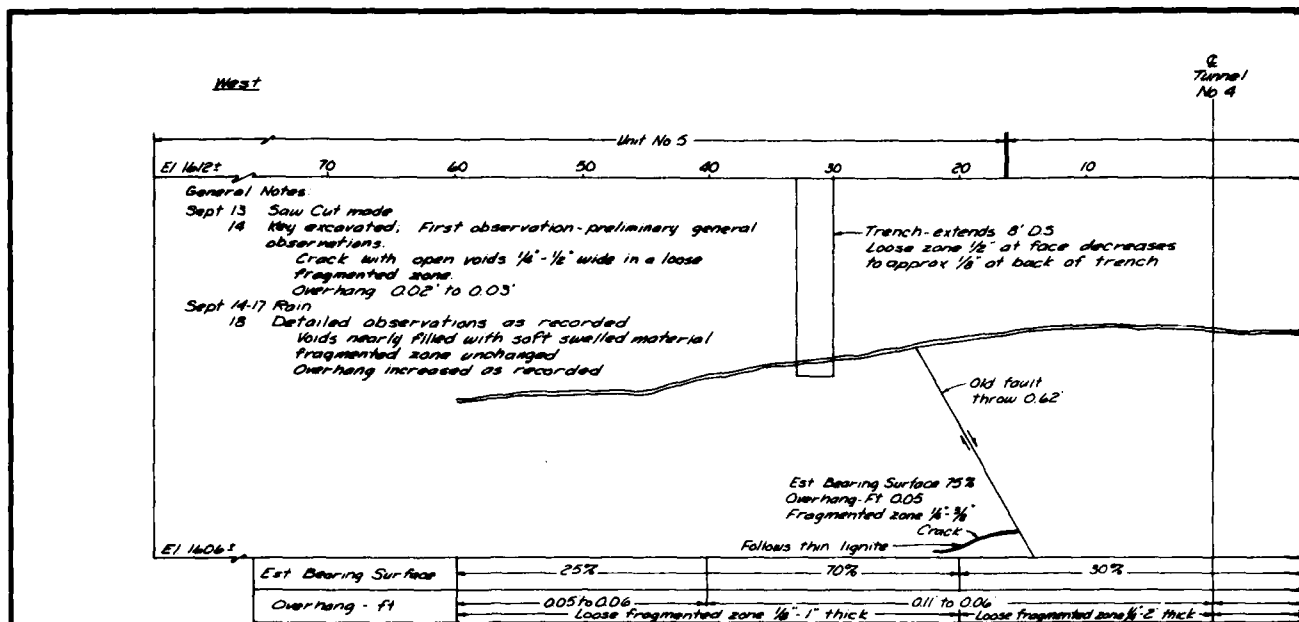


THIS PLAN ACCOMPANIES CONTRACT NO.  
DACA48 MODIFICATION NO.

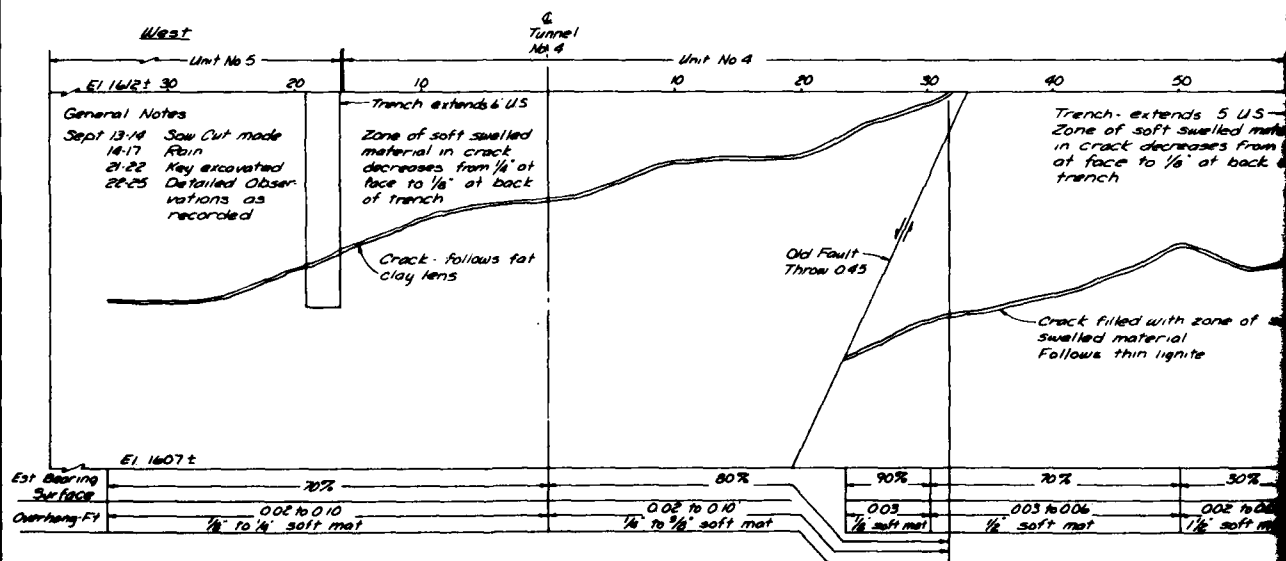
DATE	DESCRIPTION	BY	APPROVED
REVISIONS			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
MISSOURI RIVER GARRISON DAM - LAKE SAKAKAWEA			
POWERHOUSE FOUNDATION STUDY OF HORIZONTAL CRACKS EXCAVATION AND MOVEMENT DATA			
DESIGNED BY	CHECKED BY	APPROVED	DATE
DRAWN BY	CHECKED BY	APPROVED	DATE
IN CHARGE, SECTION	IN CHARGE, DISTRICT	IN CHARGE, DISTRICT	IN CHARGE, DISTRICT
IN CHARGE, DISTRICT	IN CHARGE, DISTRICT	IN CHARGE, DISTRICT	IN CHARGE, DISTRICT

2





PROFILE C-  
UPSTREAM KEY - DOWN



PROFILE D-1  
DOWNSTREAM KEY - UPST

Notes  
 For Location Plan see Dug No G07 10/14 Plate #1  
 For Geologic Sections thru keys see Dug No GPX - 6/20

SCALE  
 HOR: 1" = 5'  
 VERT: 1" = 1'



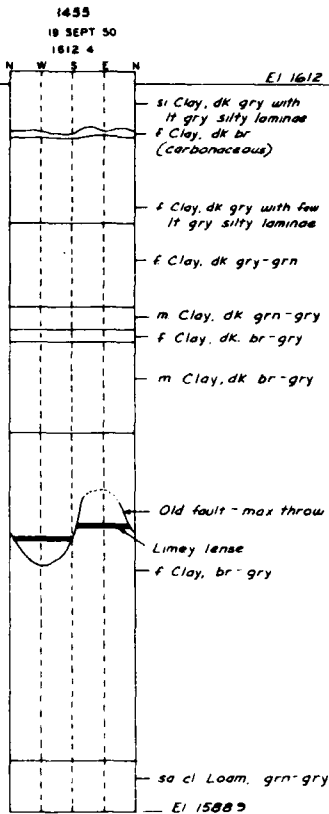
Slope 1 on 1

Sta 153+63.17

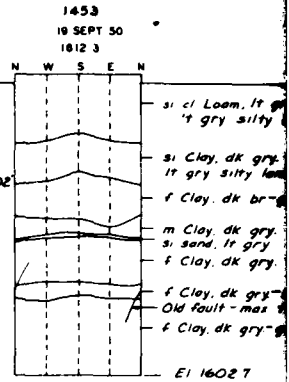
Loose fragmented zone  
1/4"-1", initially voids 1/8"-1/4"  
EI 1606

Upstream Key

Overhang 010'



Lignite 002  
(Impure)



SECTION A-A  
60 E & OUTLET WORKS

SCALE  
HOR - 1" = 5'  
VERT - 1" = 2'

Slope 1 on 1

Overhang 003'

Sta 153+63.17

Loose fragmented  
zone 1/4"-2", initially  
voids 1/8"-1/4"  
EI 1606

Overhang 005'

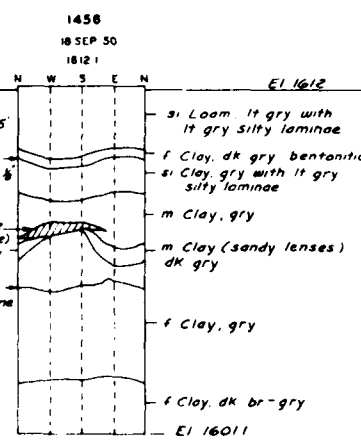
Loose fragmented  
zone 1/4"-1/2"

Overhang 005'

Loose fragmented  
zone 1/4"-1/2"

Upstream Key

Overhang 005'

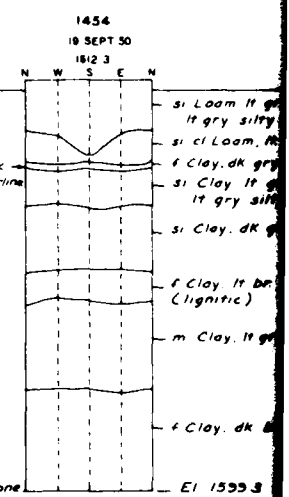


Lignite  
(Impure)  
m Clay

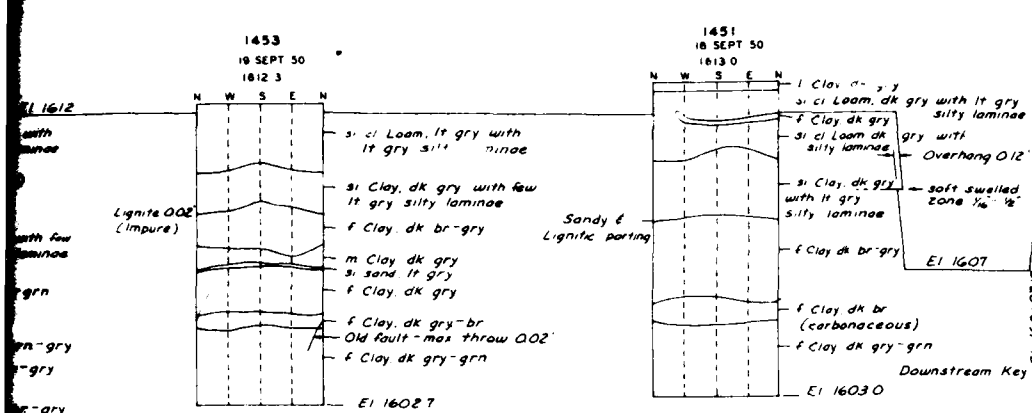
Crack  
thin hairline

Crack  
max width 1/8"

Limestone



SECTION B-B  
20 W & OUTLET WORKS

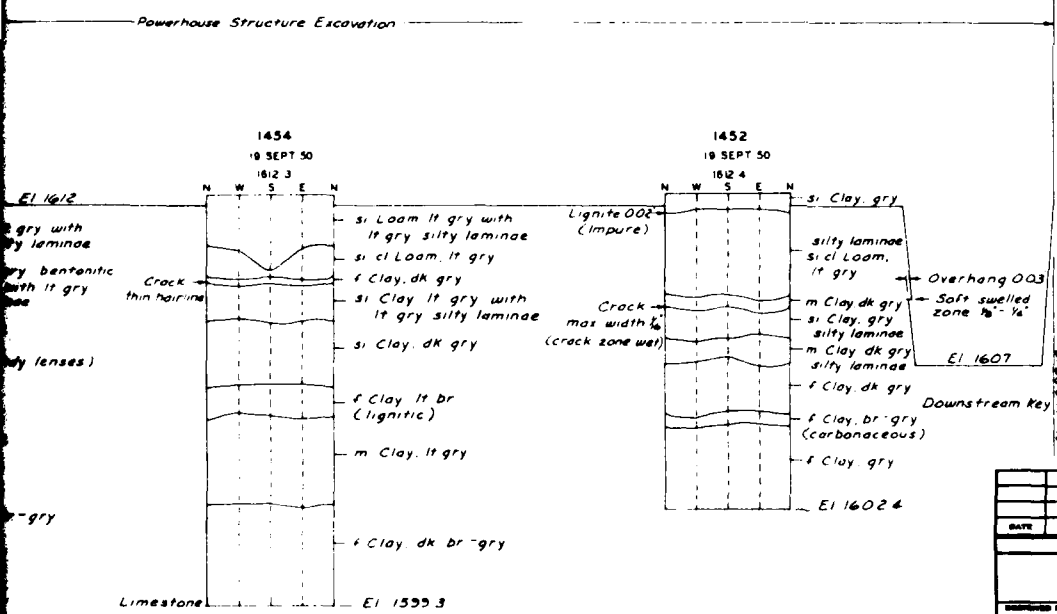


Boring 1451 re-examined and backfilled 23 Sept 50 after excavation of adjacent key completed. Hole had been open 5 days with still no development of cracks.

**SECTION A-A**  
80 E.E. OUTLET WORKS

SCALE  
HOR - 1" = 3'  
VERT - 1" = 2'

**Notes**  
Borings shown are 30" diam Auger holes, except Boring 1456 which is 42" diam for first 8 feet.  
Boring logs drawn as developments of holes to show variations of material from North face counterclockwise around the hole.  
For location Plan of Borings see Dwg No G07-1/4 Plate #1  
For Profile showing cracks observed along Upstream and Downstream Keys see Dwg No GPX-4/22



**SECTION B-B**  
20 W.E. OUTLET WORKS

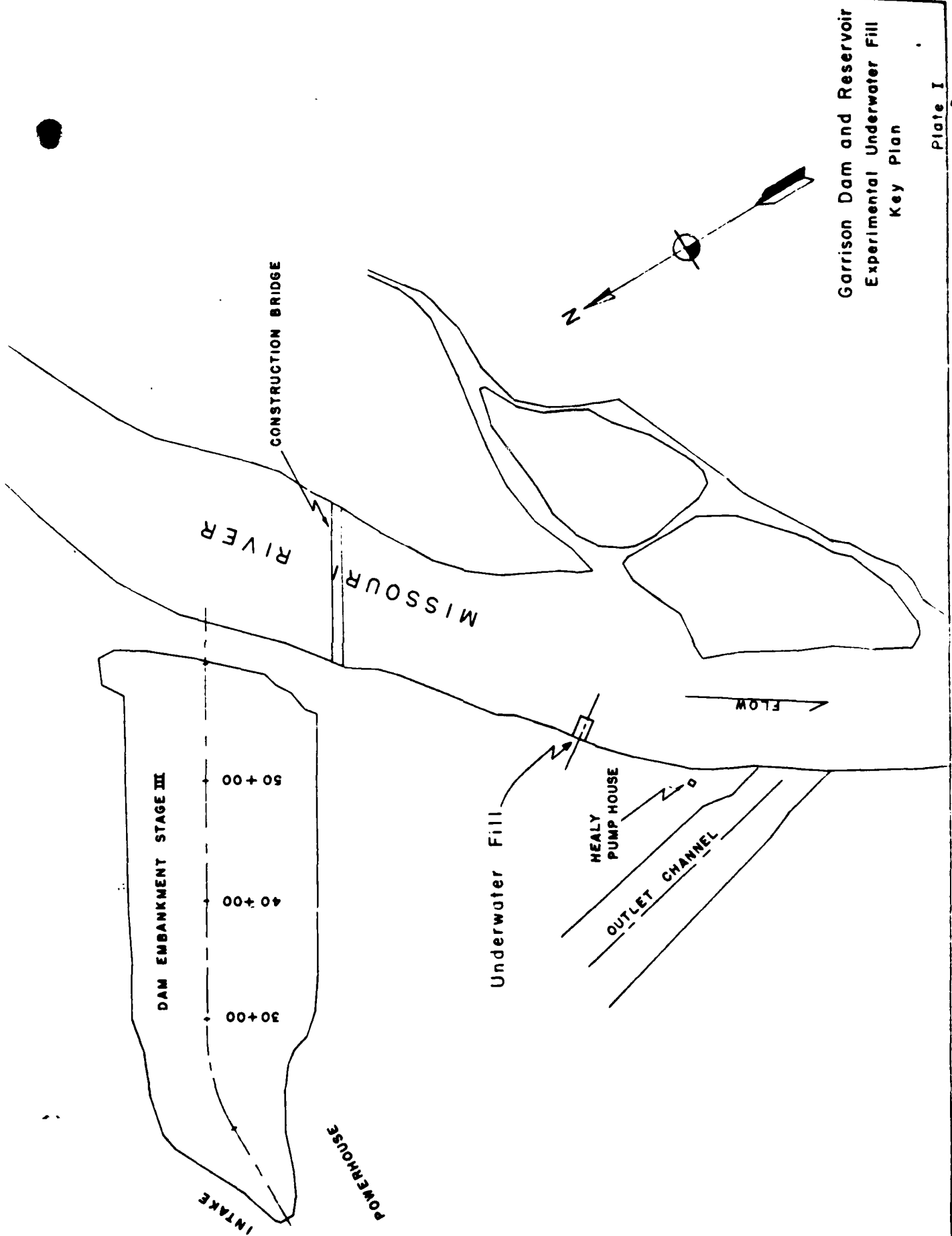


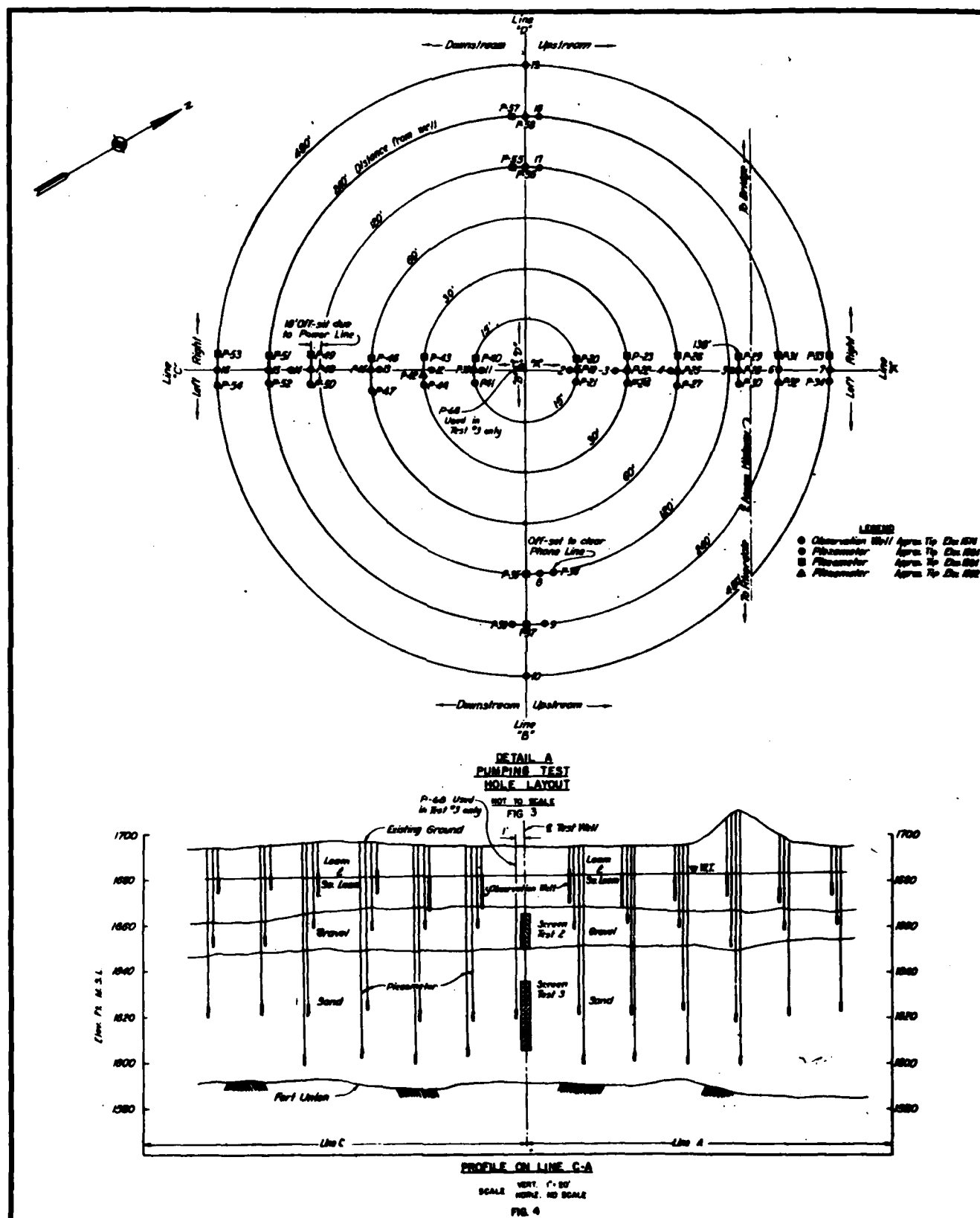
DATE		DESIGNER	SCALE	APPROVED
<b>REVISIONS</b> U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA MISSOURI RIVER <b>GARRISON DAM-LAKE SAKAKAWEA</b> <b>POWERHOUSE FOUNDATION</b> <b>STUDY OF HORIZONTAL CRACKS</b> <b>GEOLOGIC SECTIONS THRU KEYS</b>				
DESIGNED BY	CHECKED BY	APPROVED BY	DATE	
DRAWN BY	REVIEWED BY	APPROVED BY	DATE	
THIS PLAN ACCOMPANIES CONTRACT NO. DACA43		MODIFICATION NO.		

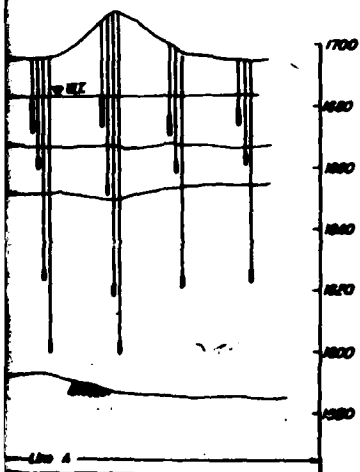
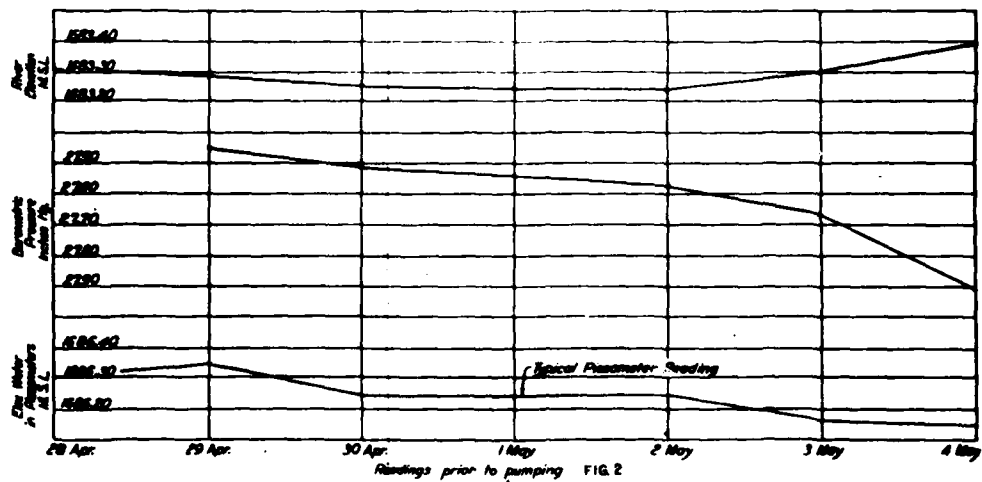
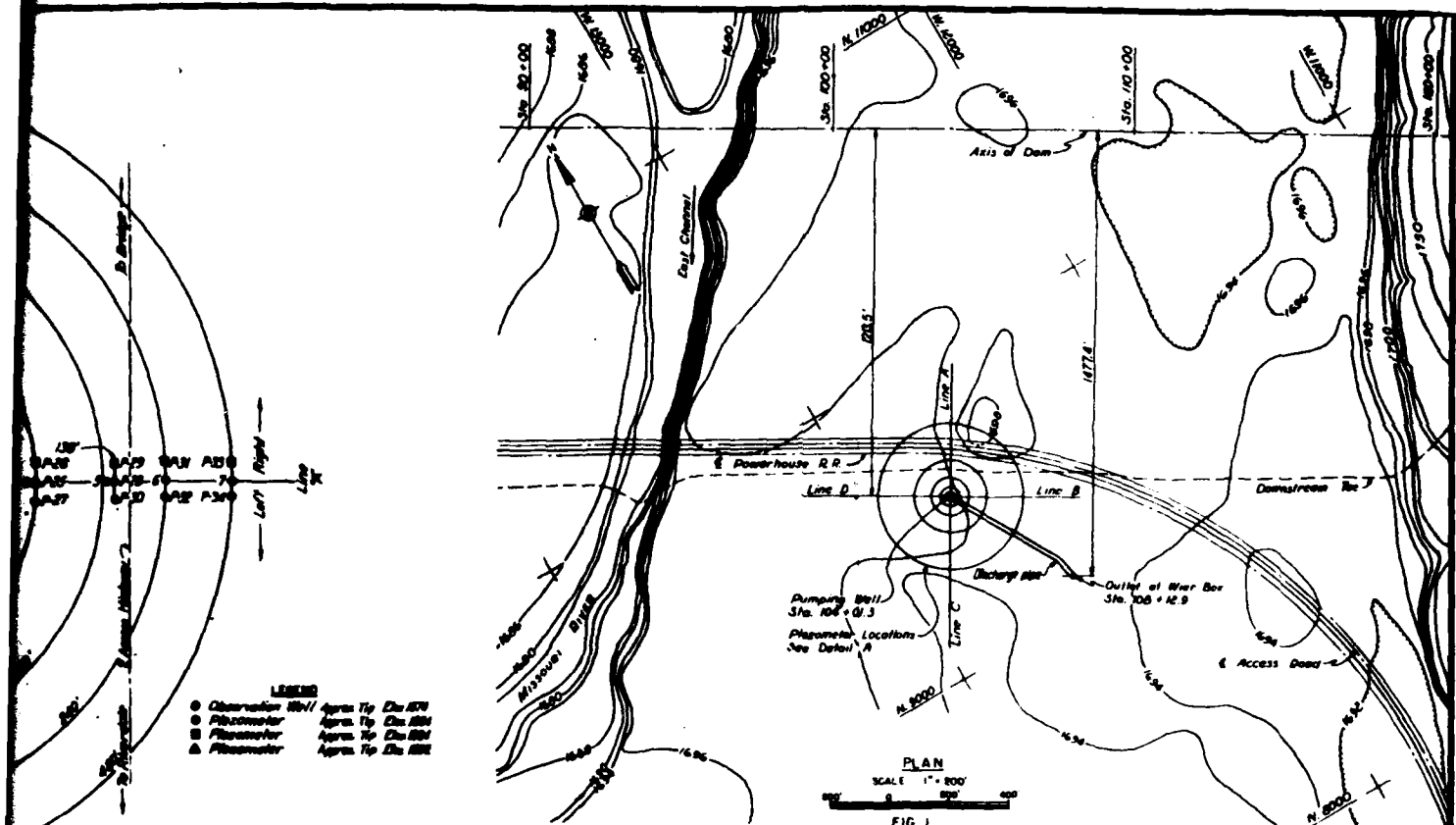
SS - THINK VALUE ENGINEERING - SS

CONSTRUCTION FOUNDATION REPORT (1982) PLATE 53

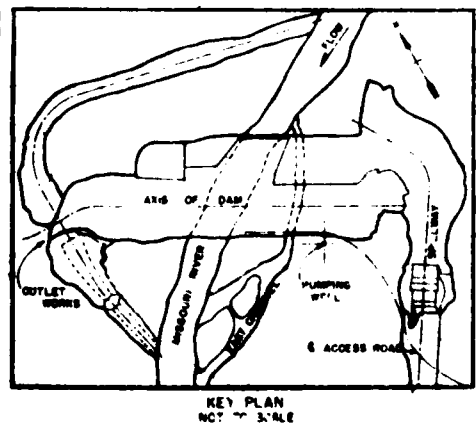
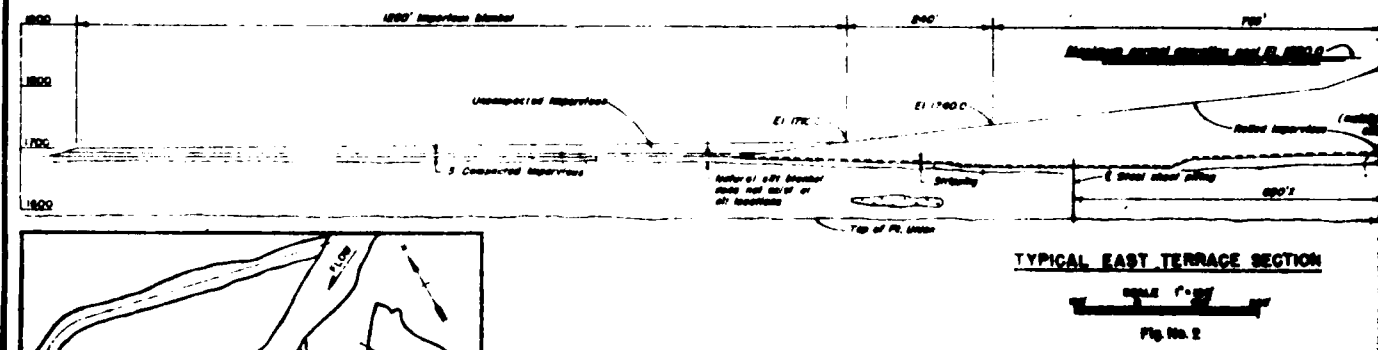
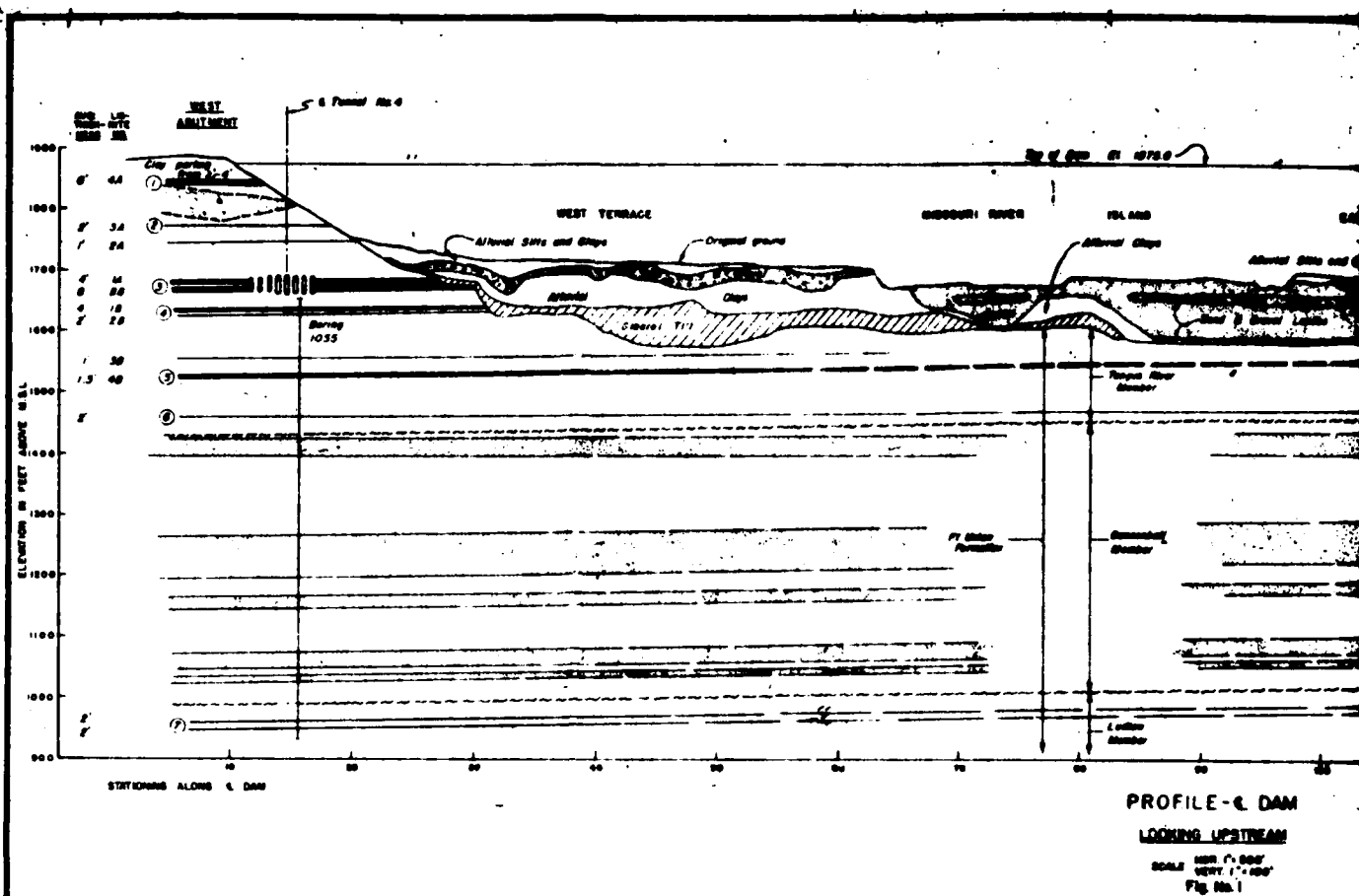
2



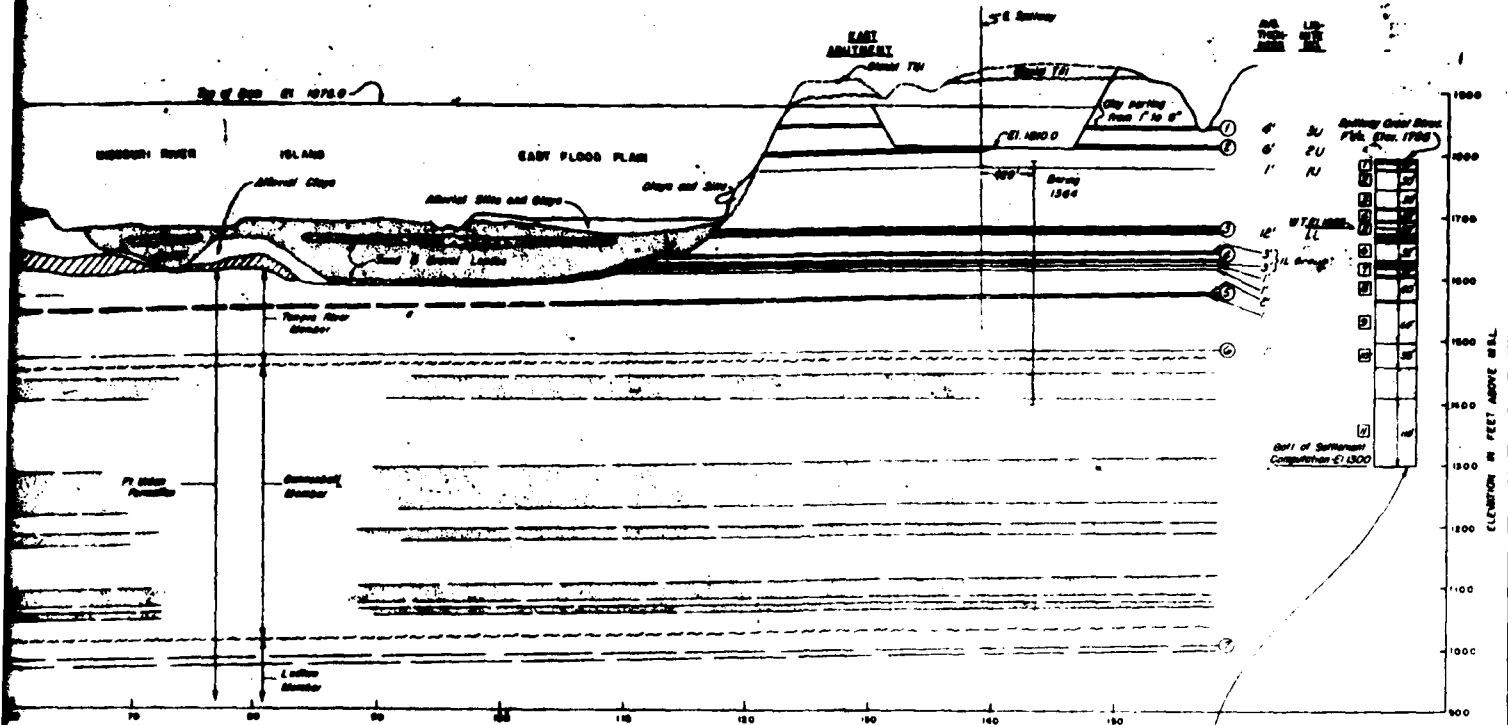




U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MINNAPOLIS, MINN.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR PUMPING TEST GENERAL LAYOUT	
DATE APR 27 1982	BY [Signature]
CHECKED BY [Signature]	
APPROVED BY [Signature]	
DRAWN BY [Signature]	
SCALE 1" = 200'	
SHEET NO. 55	







PROFILE - E DAM

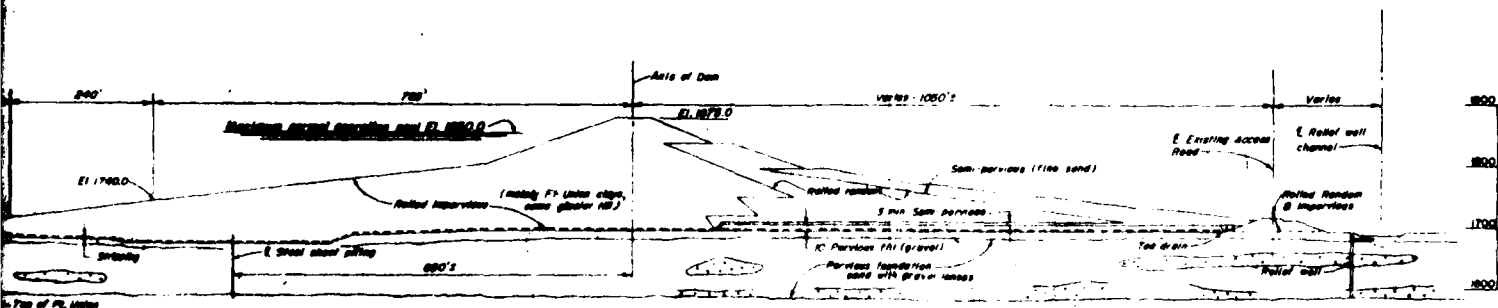
LOOKING UPSTREAM

SCALE: HORIZ. 1" = 500'  
VERT. 1" = 100'  
Fig. No. 1

NOTE

LL bed contains clay parting with maximum observed thickness of 5' approximately 4' below top of bed which is most prominent south of abutment adjacent to East Flood Plain and disappears to the north and east

Assumed simplified formation for moment analysis of the dam. The horizontal compressible layers LL and LL' are considered as non-compressible drainage layers.



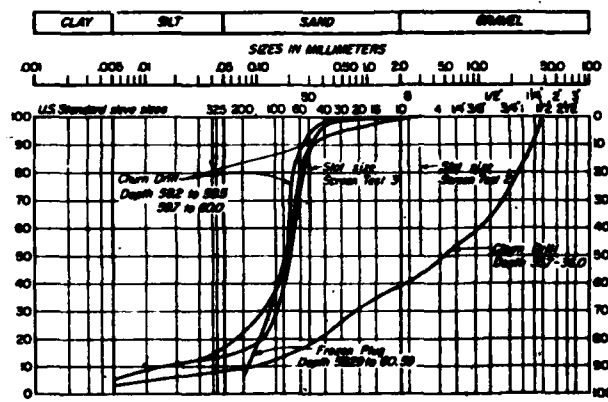
TYPICAL EAST TERRACE SECTION

SCALE: 1" = 100'

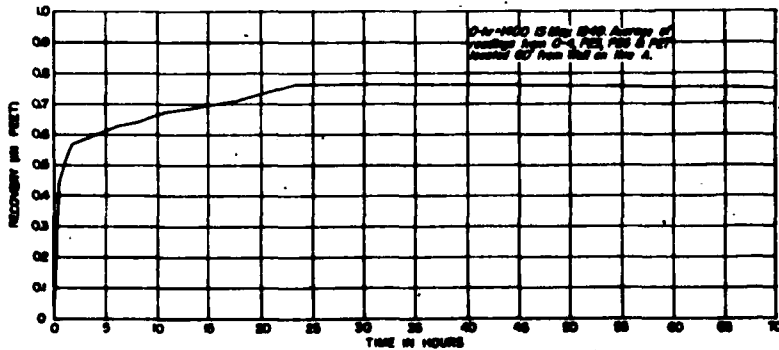
Fig. No. 2

REV	DATE	REVISIONS
1	1/16/60	1. Initial design
2	1/16/60	2. Final design
3	1/16/60	3. Construction
4	1/16/60	4. Completion
5	1/16/60	5. Final report
6	1/16/60	6. Final review
7	1/16/60	7. Final approval
8	1/16/60	8. Final sign-off
9	1/16/60	9. Final check
10	1/16/60	10. Final release
<p>U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DISTRICT NO. 2</p> <p>MISSOURI RIVER GARRISON DAM AND RESERVOIR GENERALIZED GEOLOGIC PROFILE SECTION</p> <p>DESIGNED BY: [Signature] CHECKED BY: [Signature] APPROVED BY: [Signature] DATE: 1/16/60</p> <p>FIG. NO. 1 GEX-5/60</p>		

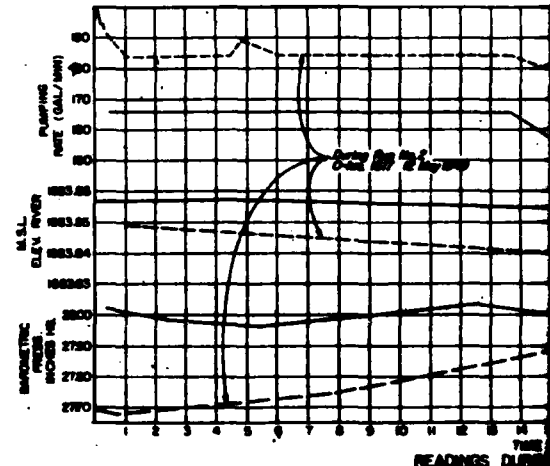
2



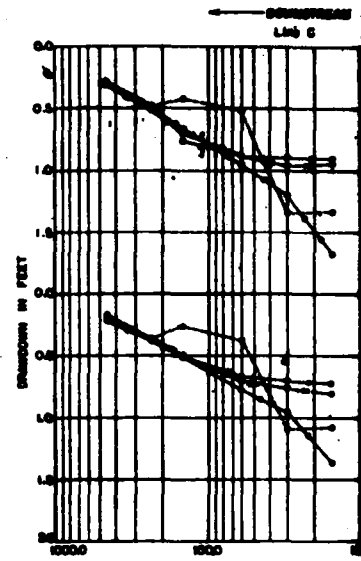
MECHANICAL ANALYSIS CURVES  
GARRISON DAM AND RESERVOIR  
HOLE 78 (TEST WELL)  
FIG. 4

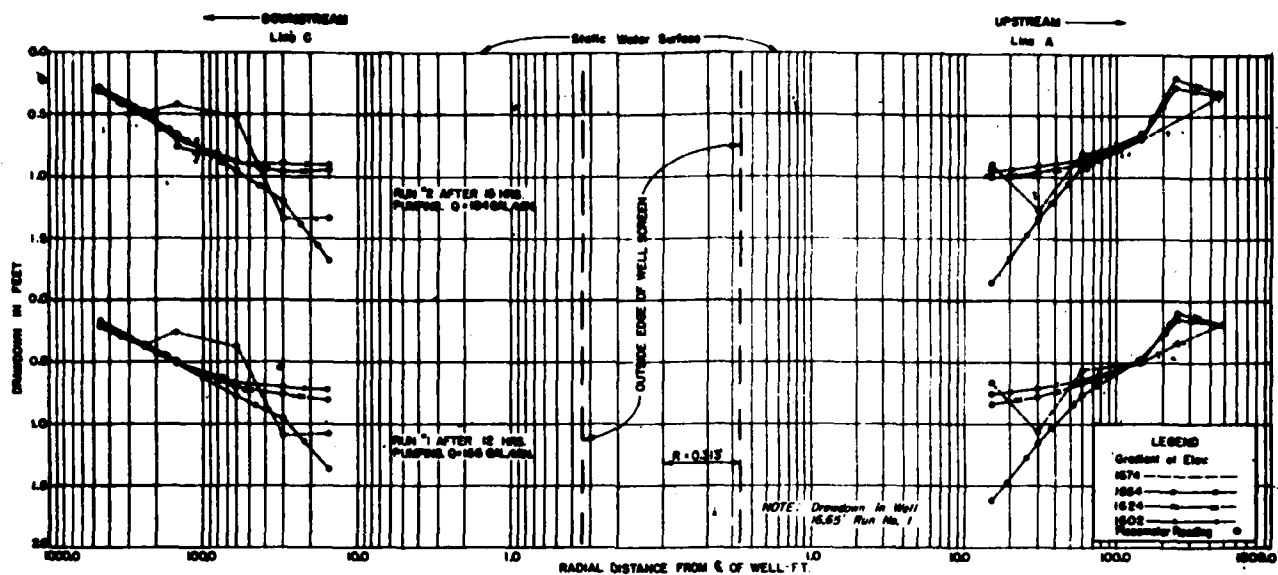


TYPICAL RECOVERY VS TIME CURVE TEST  
FIG. 5

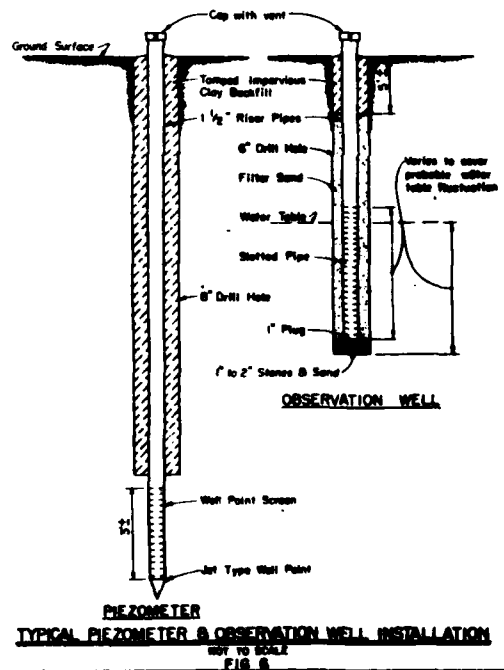
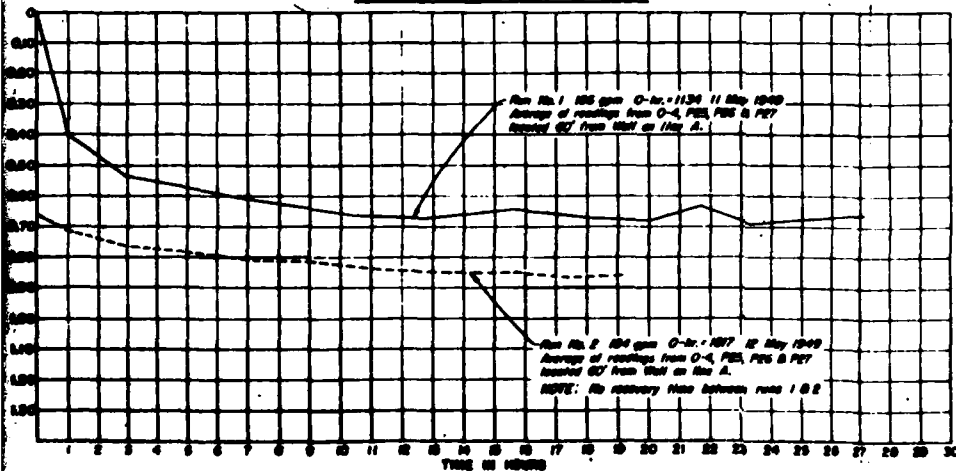
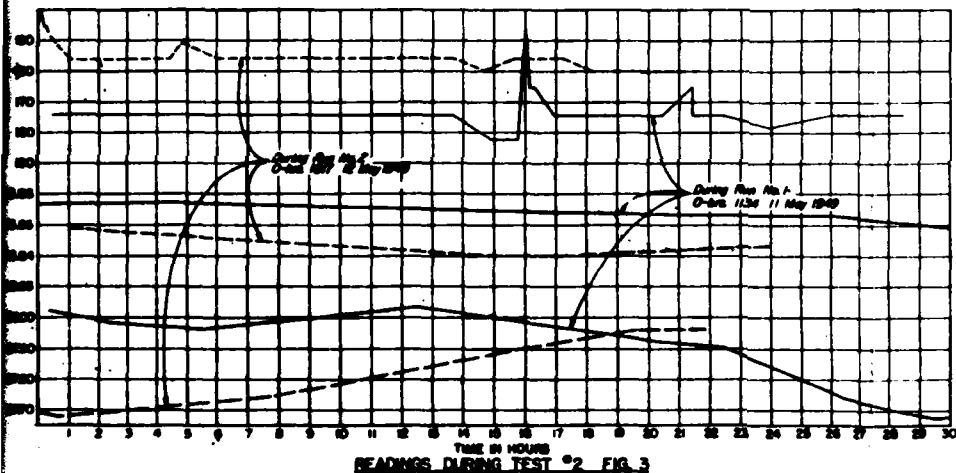


TYPICAL DRAWDOWN VS  
FIG. 6





WELL GRADIENTS ON LINES A, B, C TEST #2 RUN 1 & 2  
FIG NO. 1



MISSOURI RIVER GARRISON DAM AND RESERVOIR PUMPING TEST SUMMARY OF DATA TEST NO. 2	
DATE: 11 May 1949	
TIME: 11:34 AM	
PUMPING RATE: 1565 gpm	
WELL NO. 1	
WELL NO. 2	
WELL NO. 3	
WELL NO. 4	
WELL NO. 5	
WELL NO. 6	
WELL NO. 7	
WELL NO. 8	
WELL NO. 9	
WELL NO. 10	
WELL NO. 11	
WELL NO. 12	
WELL NO. 13	
WELL NO. 14	
WELL NO. 15	
WELL NO. 16	
WELL NO. 17	
WELL NO. 18	
WELL NO. 19	
WELL NO. 20	
WELL NO. 21	
WELL NO. 22	
WELL NO. 23	
WELL NO. 24	
WELL NO. 25	
WELL NO. 26	
WELL NO. 27	
WELL NO. 28	
WELL NO. 29	
WELL NO. 30	

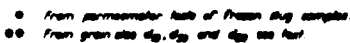
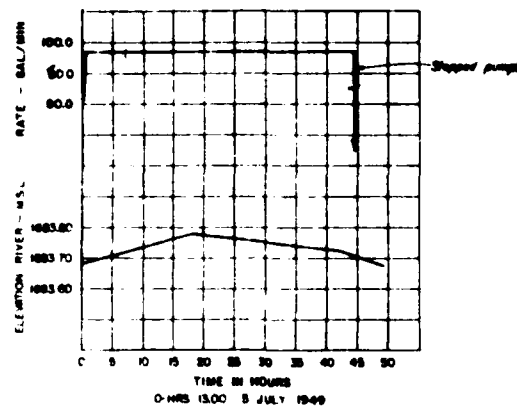
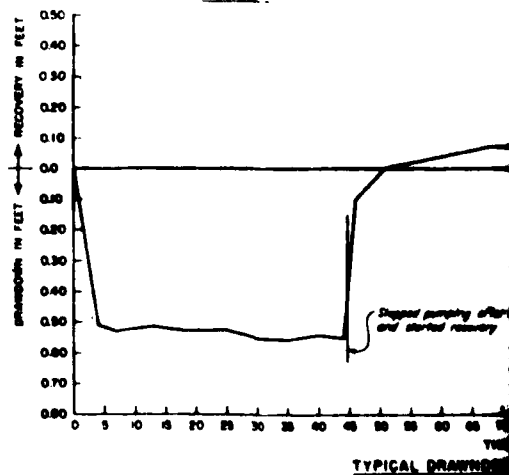


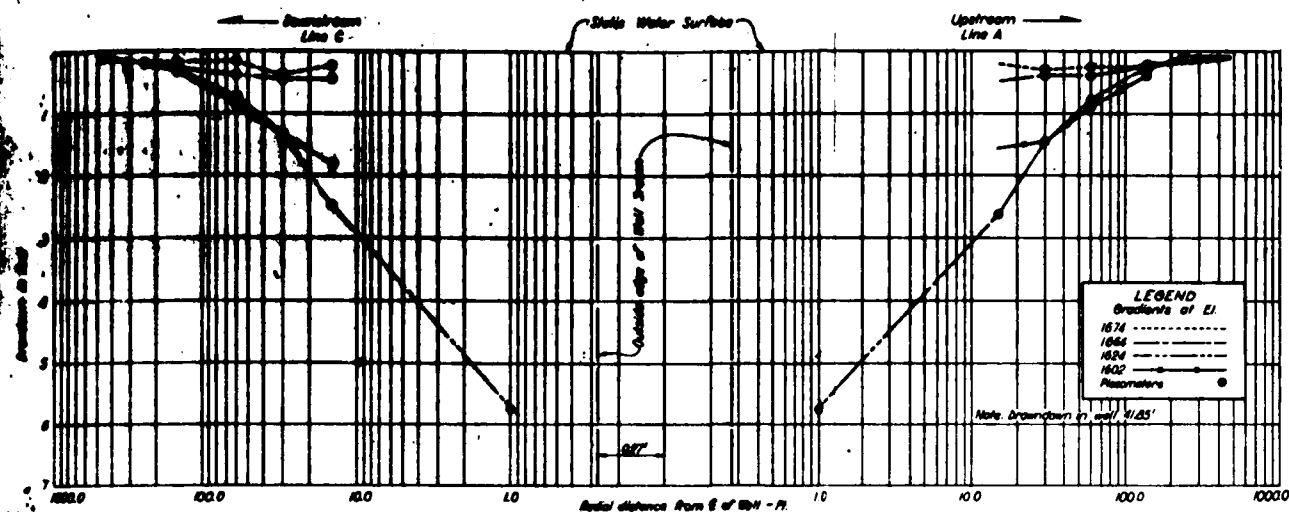
FIG. NO. 4



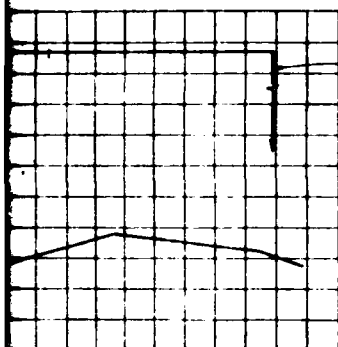
*Note: Barometric pressure readings taken during Test #3 were lost or destroyed.*

READINGS DURING TEST #3  
FIG NO. 2

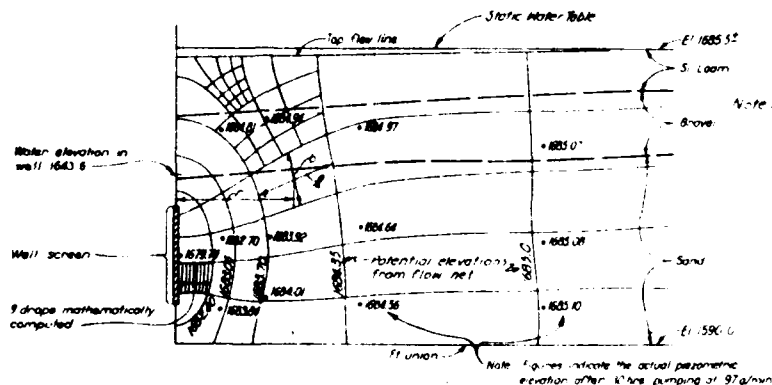




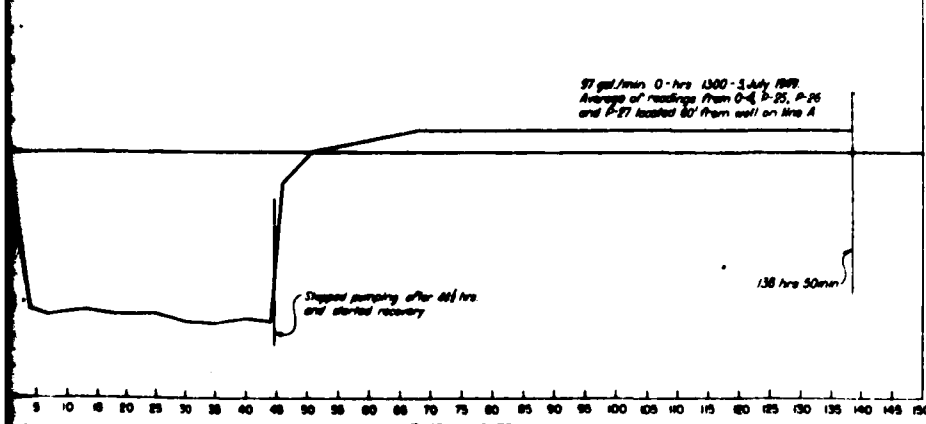
WELL GRADIENTS ON LINES ABC  
TEST #3 AFTER 30 HRS. PUMPING AT 97 GPM.  
FIG. NO. 1



READINGS DURING TEST #3  
FIG. NO. 2



FLOW NET - TEST #3  
ASSUMED HOMOGENEOUS FOUNDATION ON LINE A  
FIG. NO. 3  
SCALE 1" = 20'

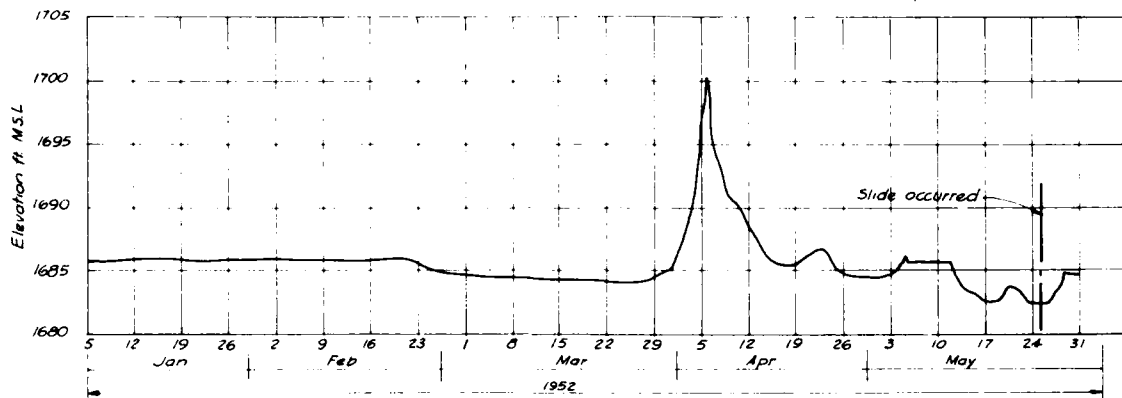


TYPICAL DRAWDOWN VS TIME CURVE - TEST #3  
FIG. NO. 4

DATE		REVISION NUMBER OF ALL	
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MISSOURI RIVER GARRISON DAM AND RESERVOIR PUMPING TEST SUMMARY OF DATA TEST NO 3			
PROJECT NO.		DRAWN BY	
CHECKED BY		DATE	
APPROVED BY		DATE	
SCALE		SHEET NO.	
TOTAL SHEETS		DATE	

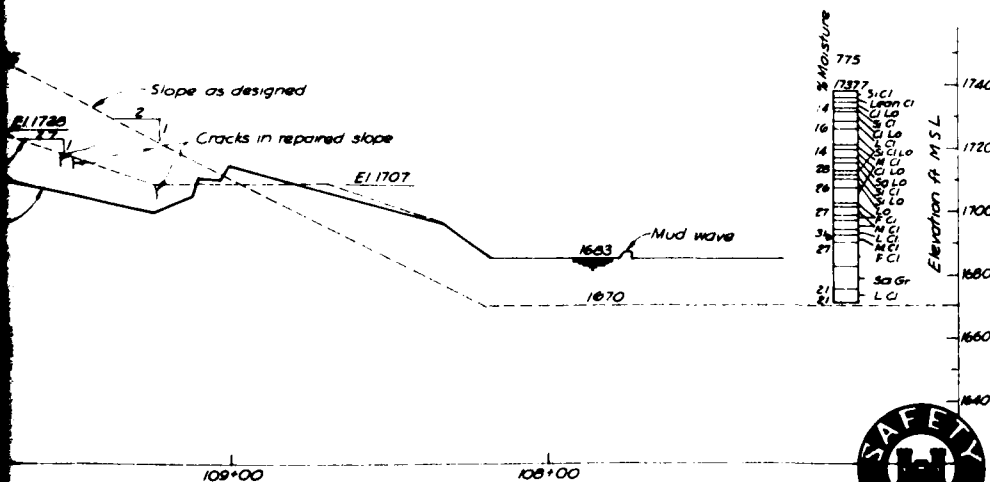


775  
1683  
DAM 25 May 52  
exposed 1" above water surface  
at 10:00 AM 25 May 52  
mass after it slid



HYDROGRAPH MISSOURI RIVER - AT GARRISON DAM

SCALE: VERTICAL 1" = 5'



THIS DRAWING HAS BEEN REDUCED TO  
THREE-FOURTHS THE ORIGINAL SCALE.

DATE	DESCRIPTION	NAME	APPROV
REVISIONS			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
MISSOURI RIVER GARRISON DAM - LAKE SAKAKAWEA SLIDE PLUG INTAKE CHANNEL STA. 110			
DESIGNED BY	CHECKED BY	APPROVED BY	DATE
CONSTRUCTED BY	INSPECTED BY	APPROVED BY	DATE
THIS DRAWING SECTION		DATE	
SCALE AS SHOWN		DATE	
DATE		DATE	

THIS PLAN ACCOMPANIES CONTRACT NO.  
BAC448 MODIFICATION NO.

88 - THINK VALUE ENGINEERING - 88

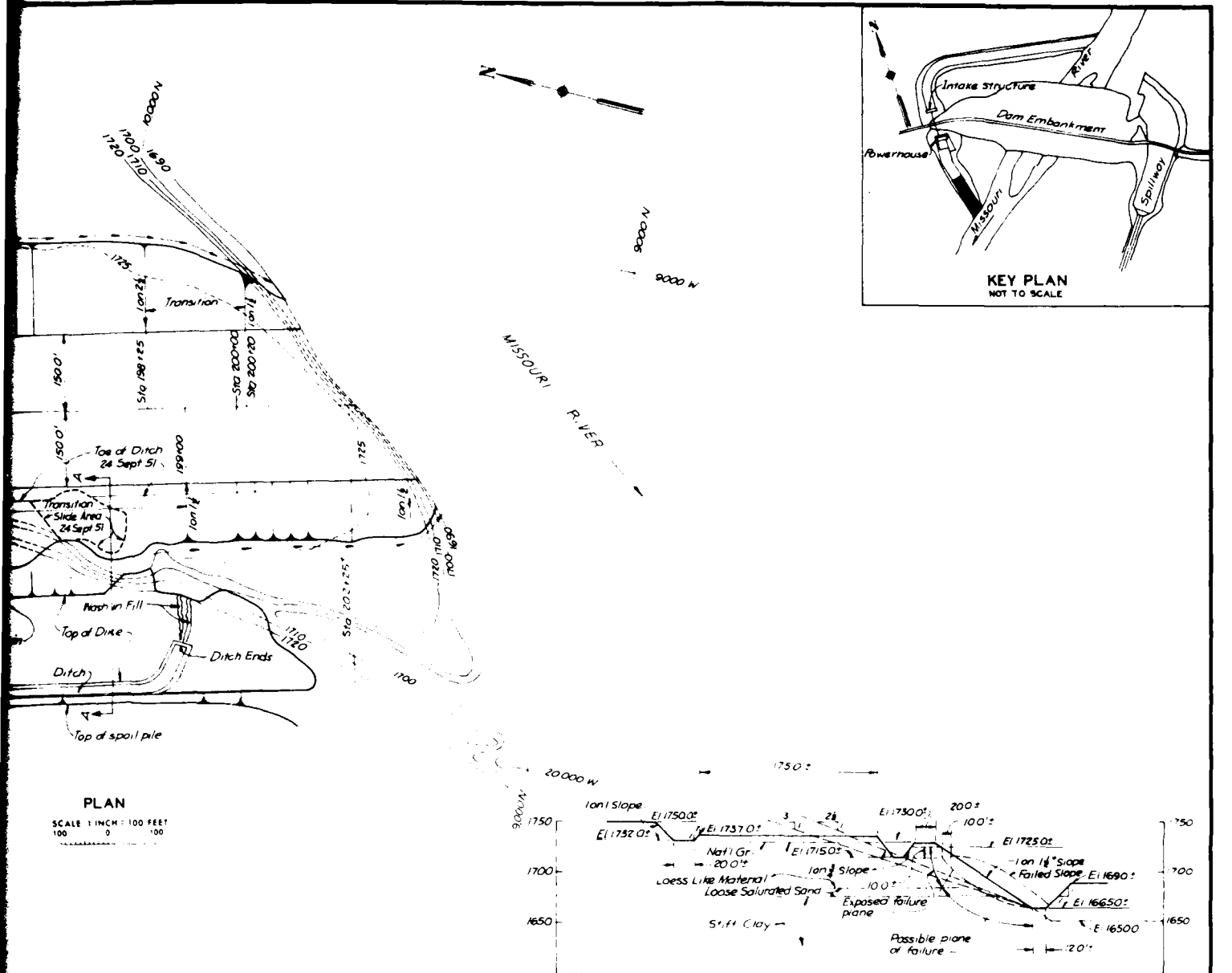
CONSTRUCTION FOUNDATION REPORT (1952) PLATE 39

U. S. GOVERNMENT PRINTING OFFICE: 1952 O-525-100

2







DATE	DESCRIPTION	DATE	APPROVED
<b>REVISIONS</b> U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA MISSOURI RIVER <b>GARRISON DAM - LAKE SAKAKAWEA</b> <b>FIRST SLIDE</b> <b>OUTLET CHANNEL</b>			
DESIGNED BY	CHECKED BY	DATE	
DRAWN BY	APPROVED BY	DATE	
DRAWING NO. <b>DACA43</b> SHEET NO. <b>1</b> OF <b>1</b>		DRAWING REVISION DATE	

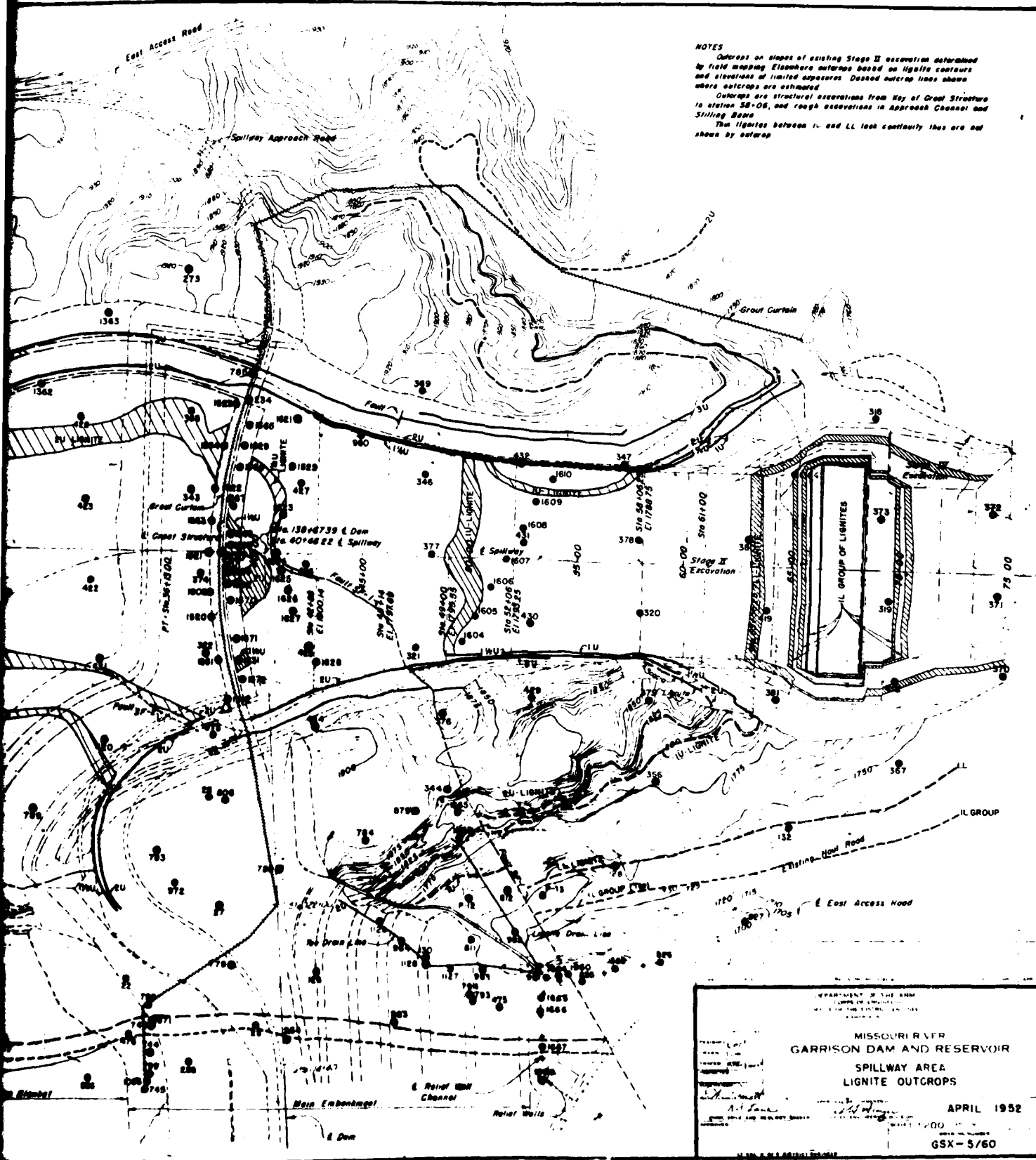


THIS PLAN ACCOMPANIES CONTRACT NO. **DACA43**  
MODIFICATION NO. **1**

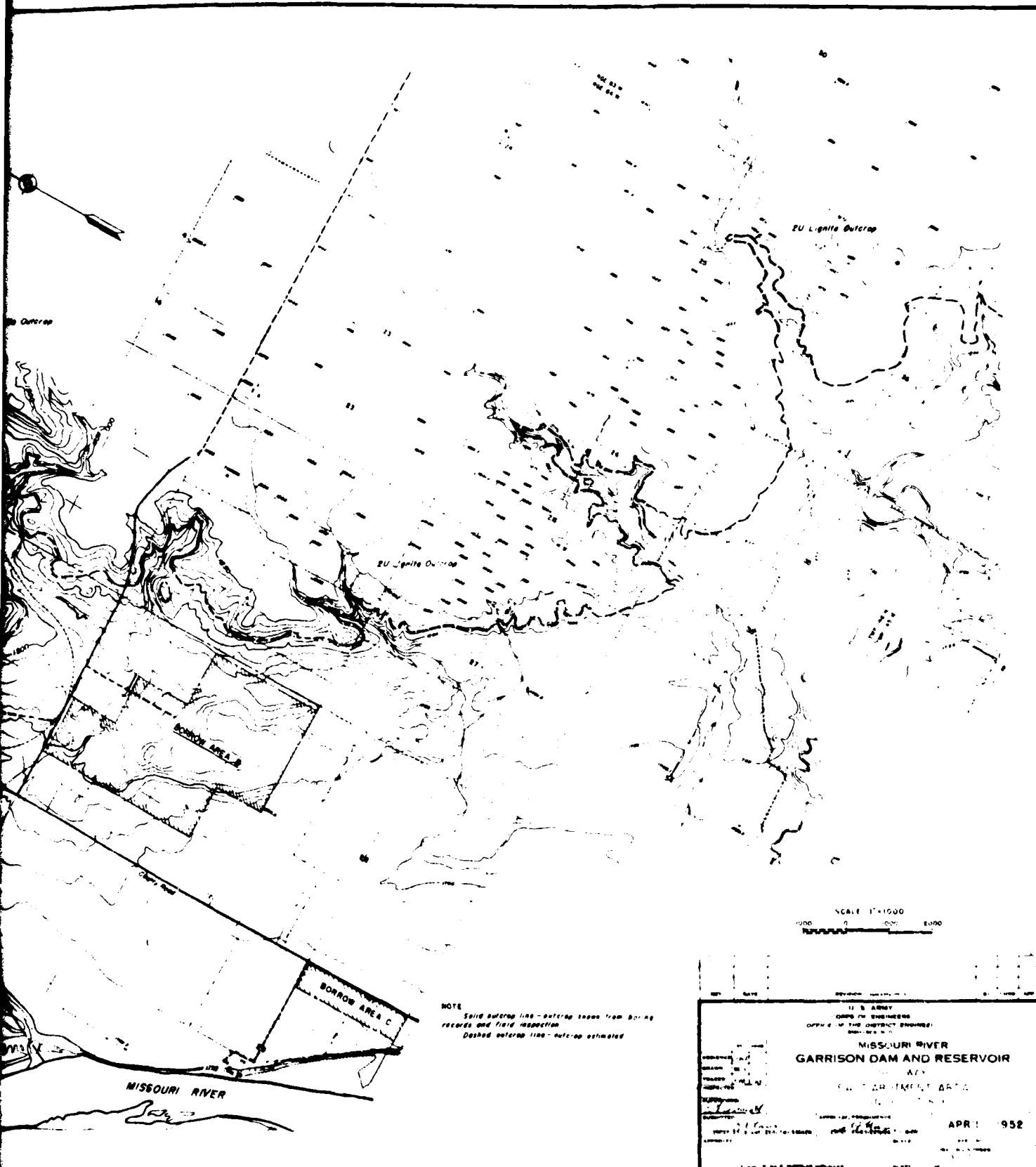
\$\$ - THINK VALUE ENGINEERING - \$\$

CONSTRUCTION FOUNDATION REPORT (1982) PLATE 60



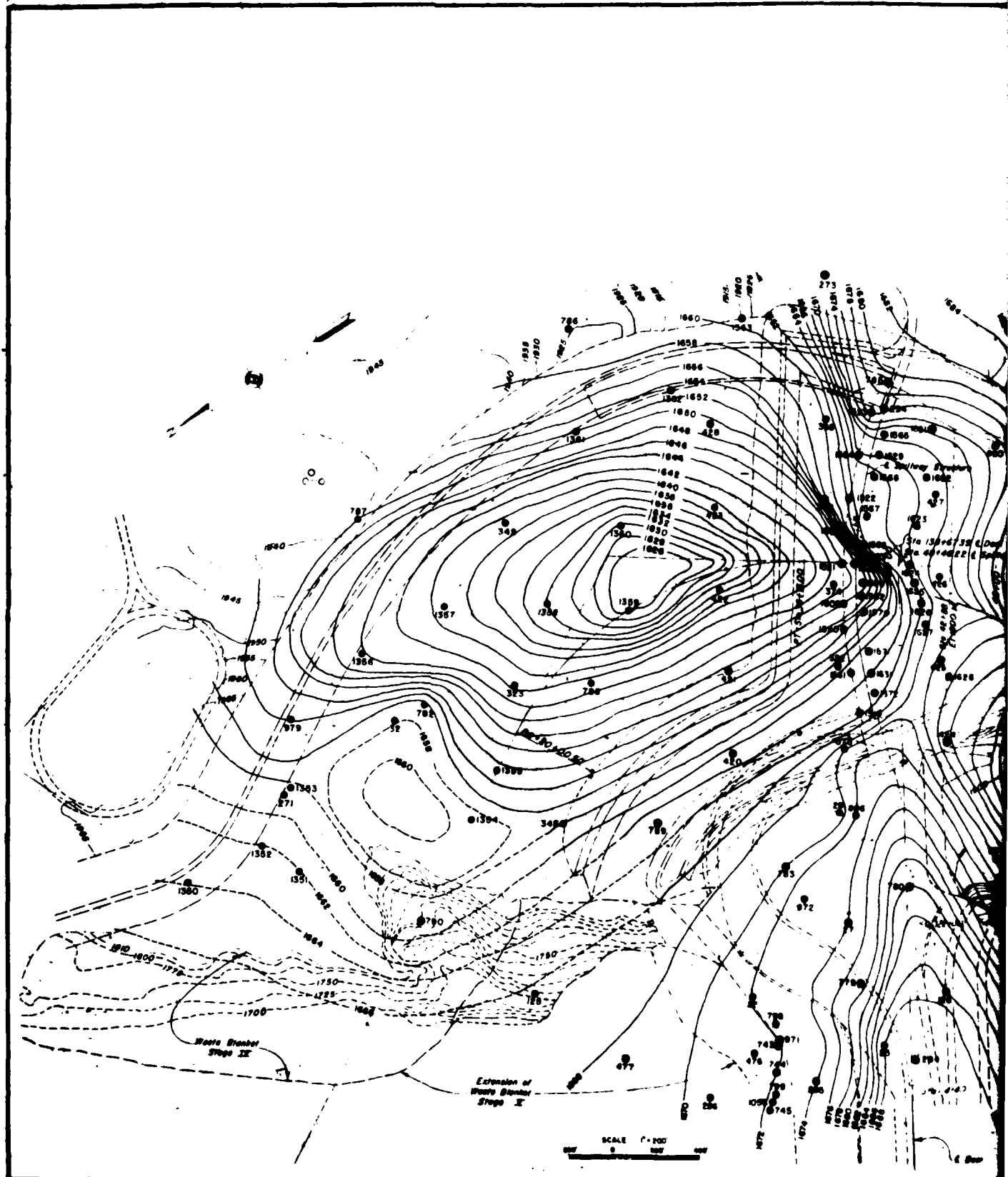


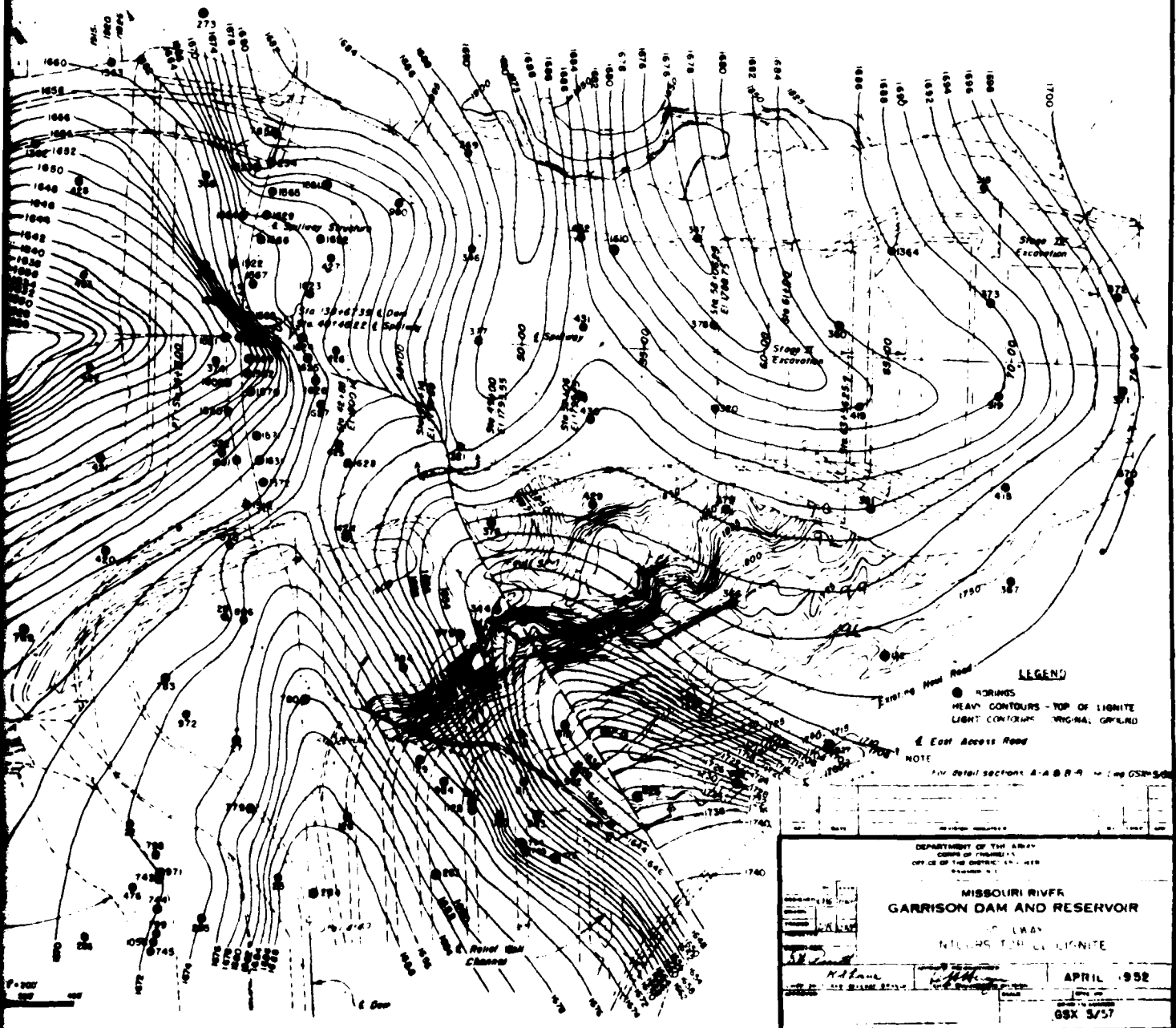




NOTE  
 Solid outcrop line - outcrop shown from boring  
 records and field inspection  
 Dashed outcrop line - outcrop estimated

MISSOURI RIVER GARRISON DAM AND RESERVOIR CIVIL ENGINEERING APR 1 1952	
DESIGNED BY CHECKED BY DRAWN BY APPROVED BY	PROJECT NO. SHEET NO. 62



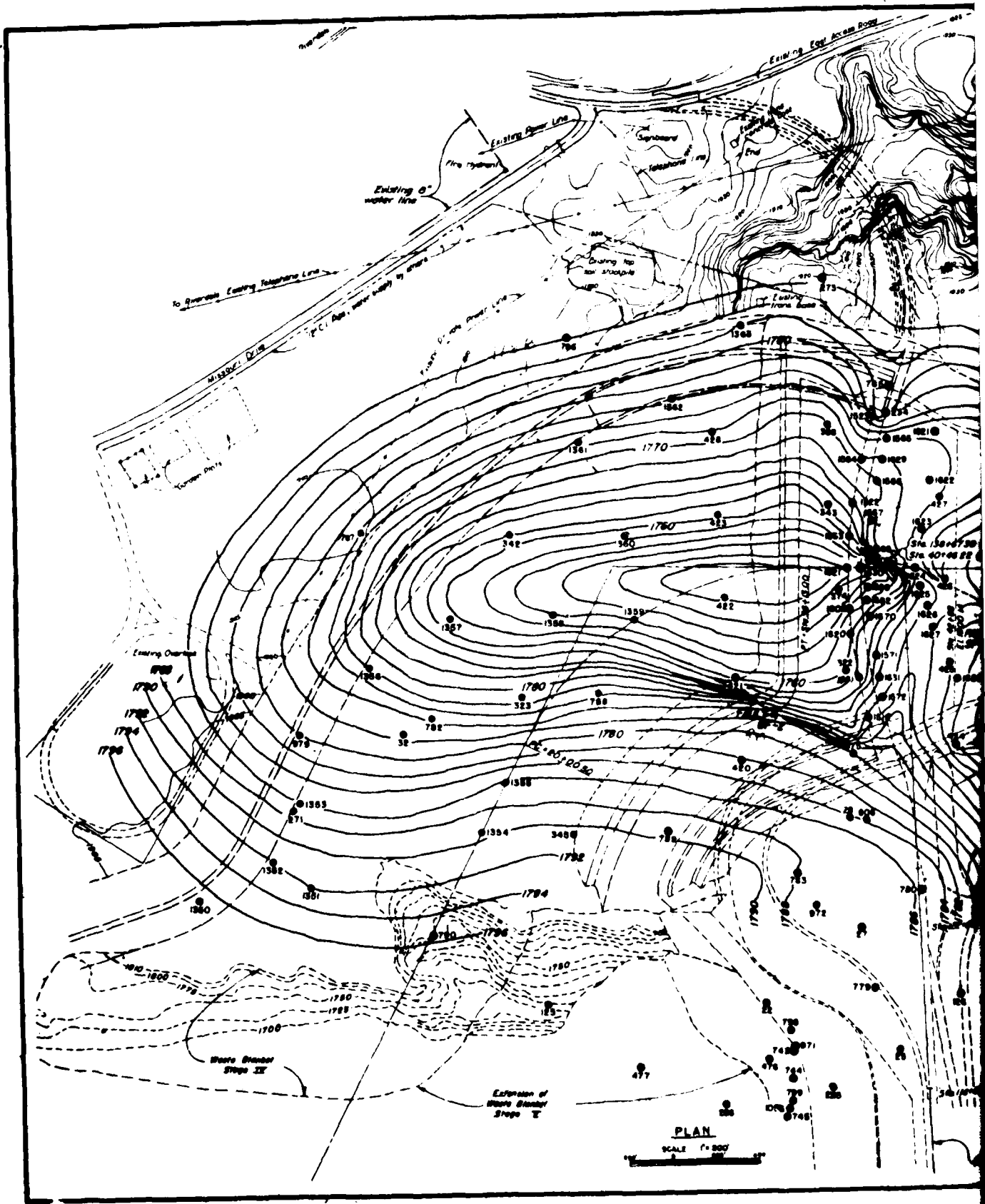


CONSTRUCTION FOUNDATION REPORT

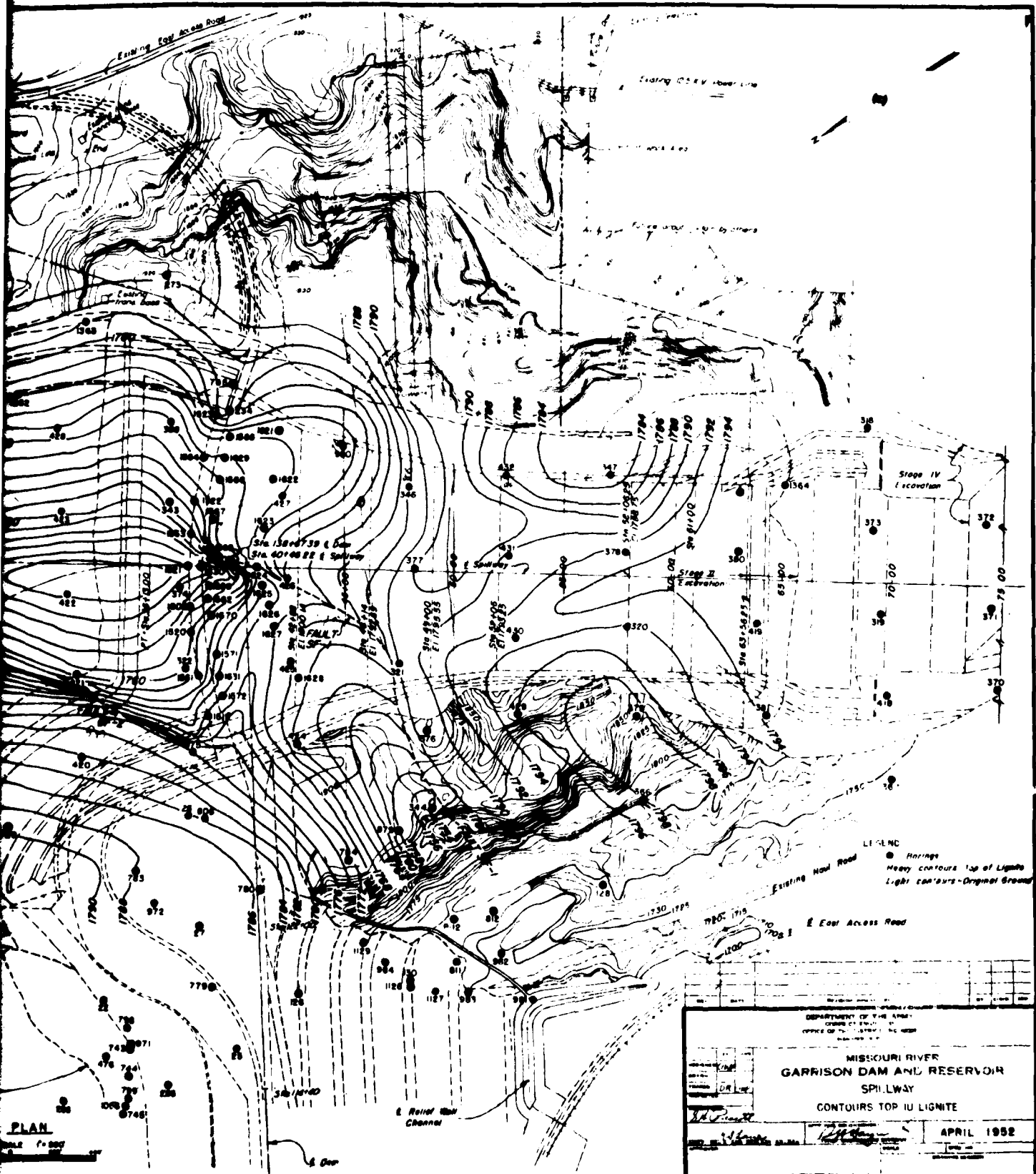
(1982)

PLATE 63

2



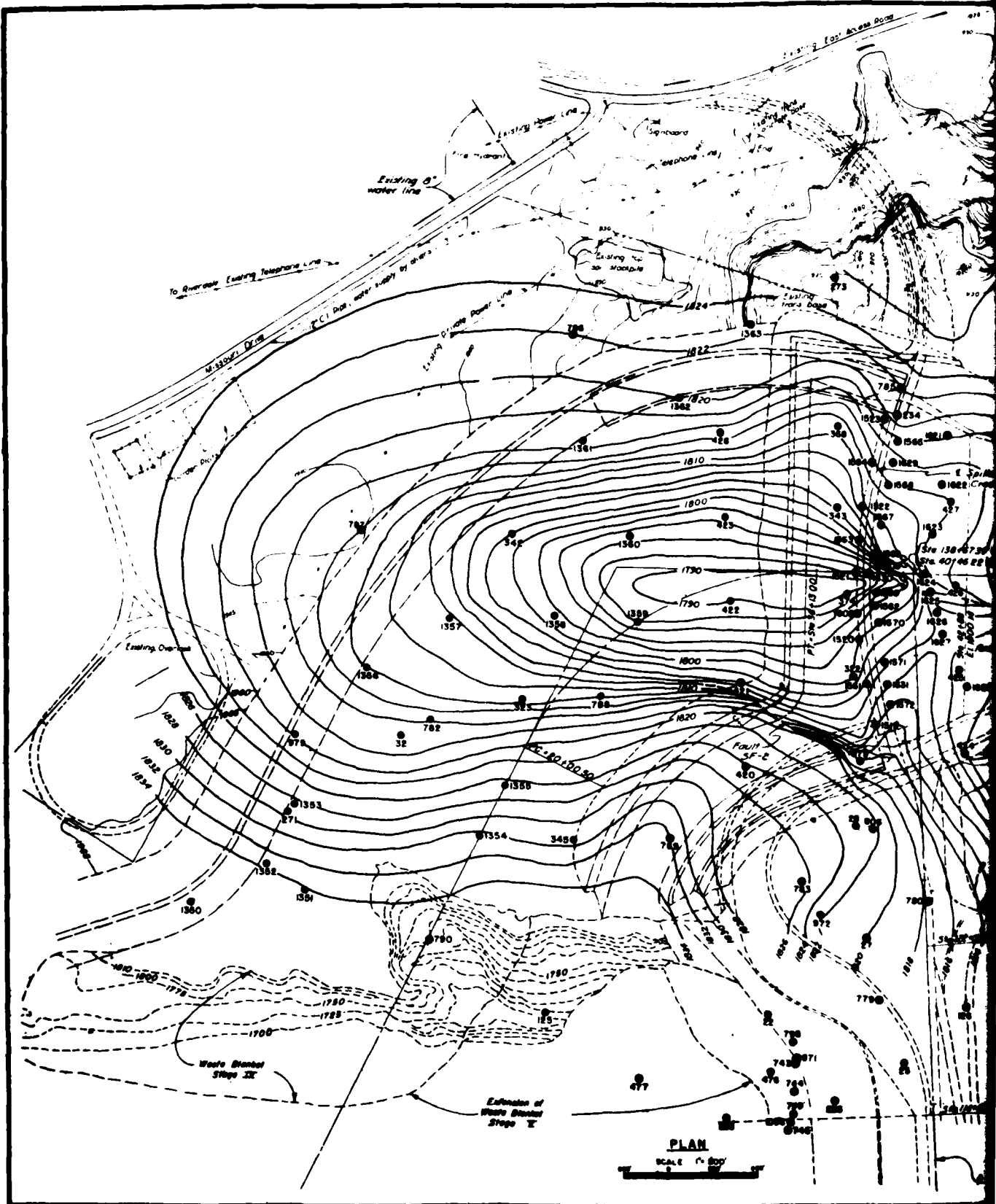


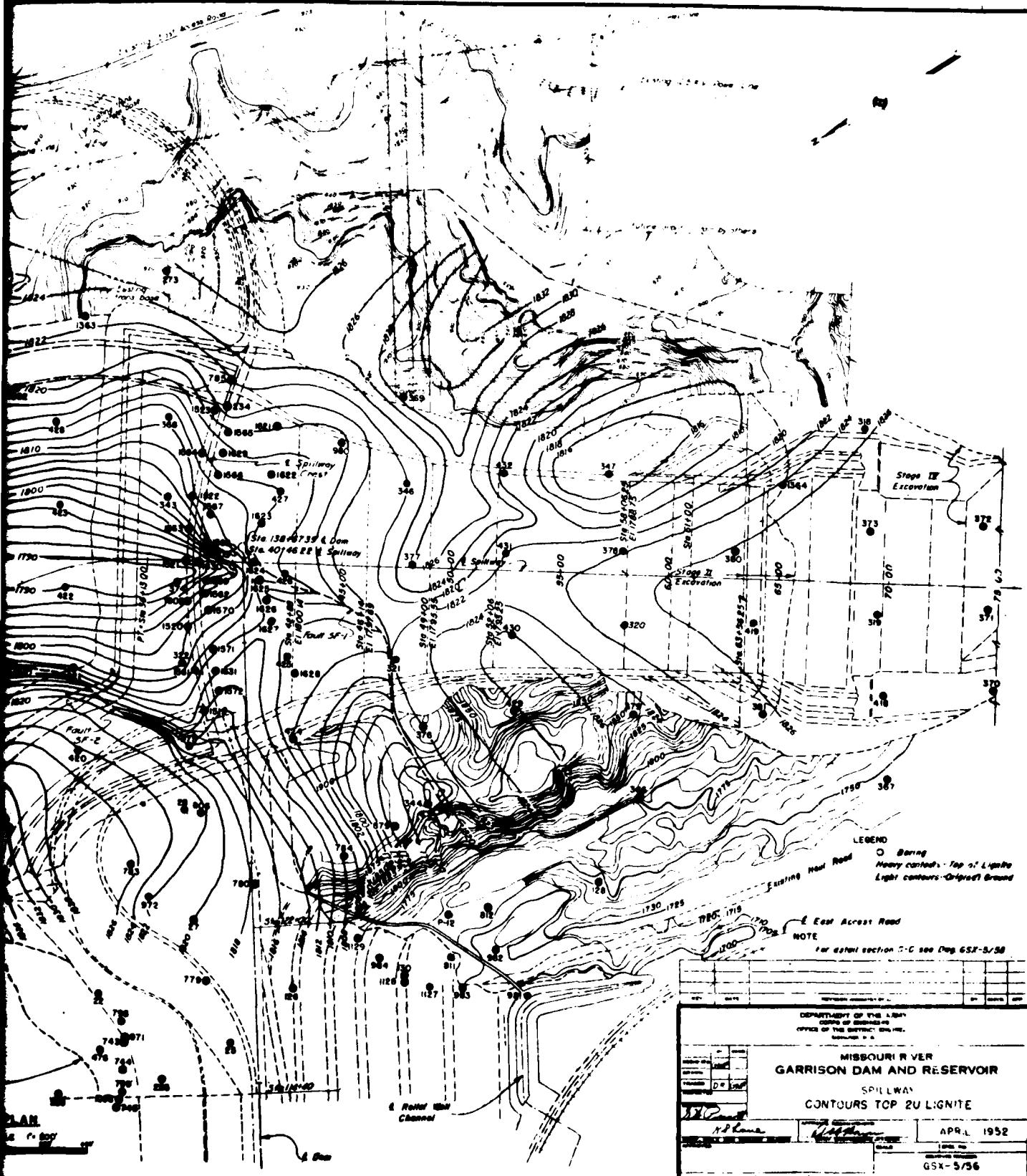


CONSTRUCTION FOUNDATION REPORT

(1982)

PLATE 64



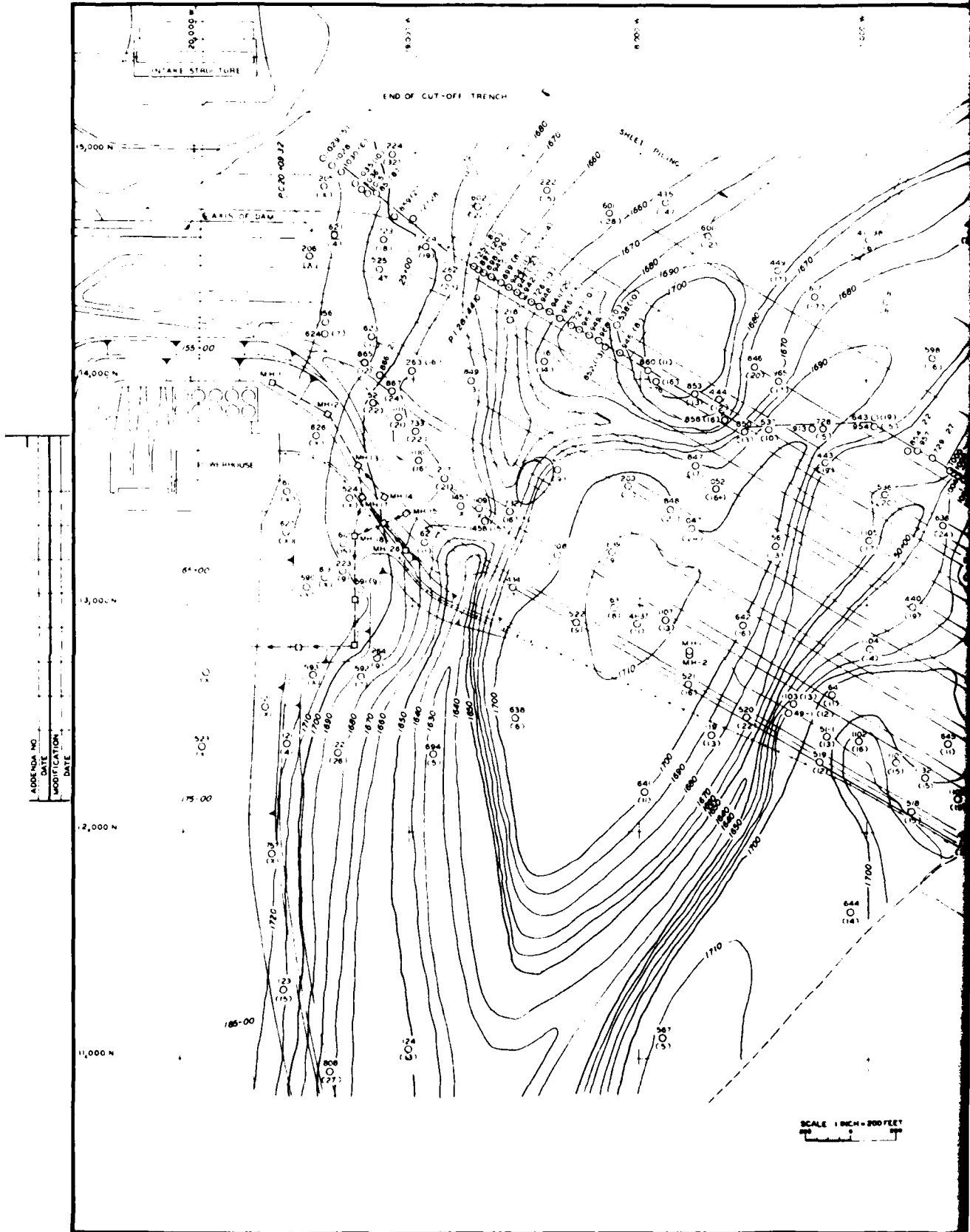


LEGEND  
 ○ Boring  
 Heavy dotted - Top of Lignite  
 Light contours - Graded Ground

NOTE  
 For detail section T-C see Map GSX-5/58

DEPARTMENT OF THE ARMY OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY CONTOURS TOP 20 LIGNITE	
DATE APRIL 1952	BY GSX-5/56

# CORPS OF ENGINEERS



APPENDIX NO.  
DATE  
MODIFICATION  
DATE

SCALE 1 INCH = 200 FEET



SCALE 1 INCH = 200 FEET

**LEGEND:**

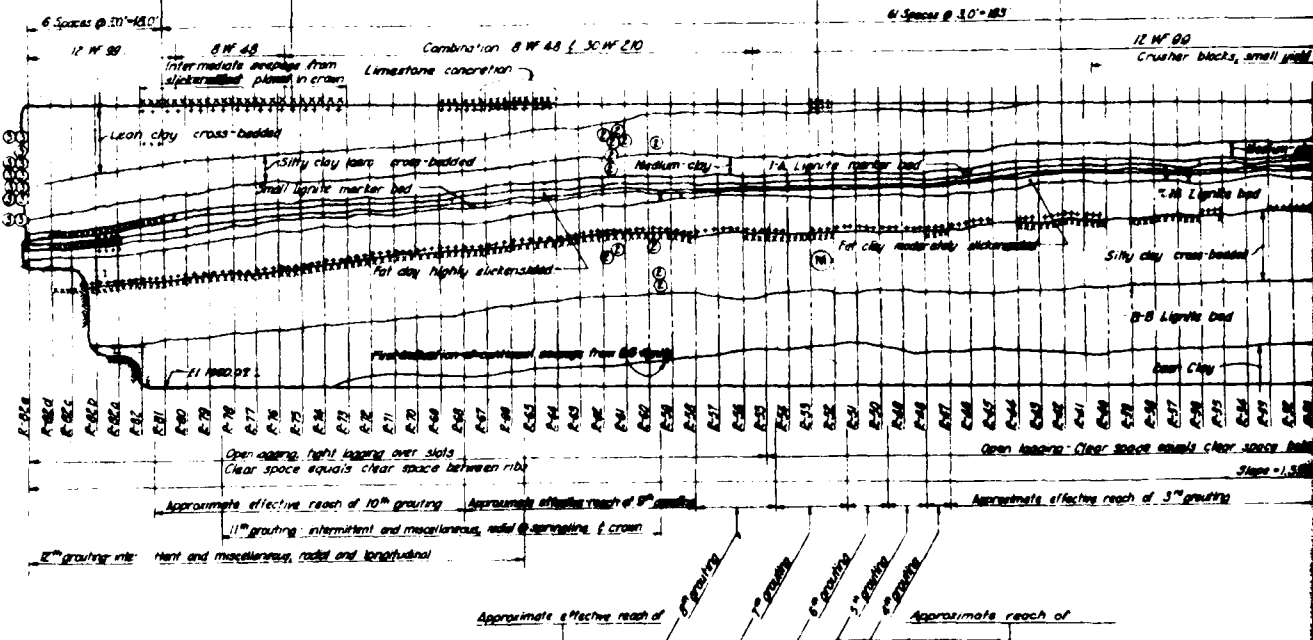
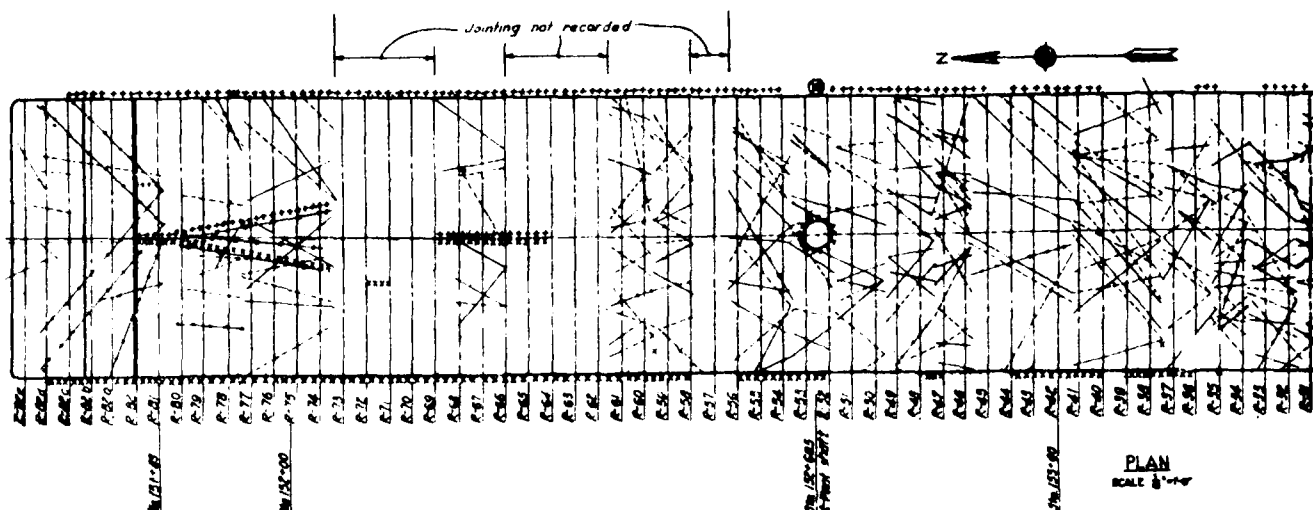
- 412 BORING NUMBER
- (20) THICKNESS OF SAND AND GRAVEL
- X HORIZON NOT ENCOUNTERED
- POWERHOUSE AND SWITCHYARD DRAINAGE
- SHEET PILING
- CUT-OFF TRENCH



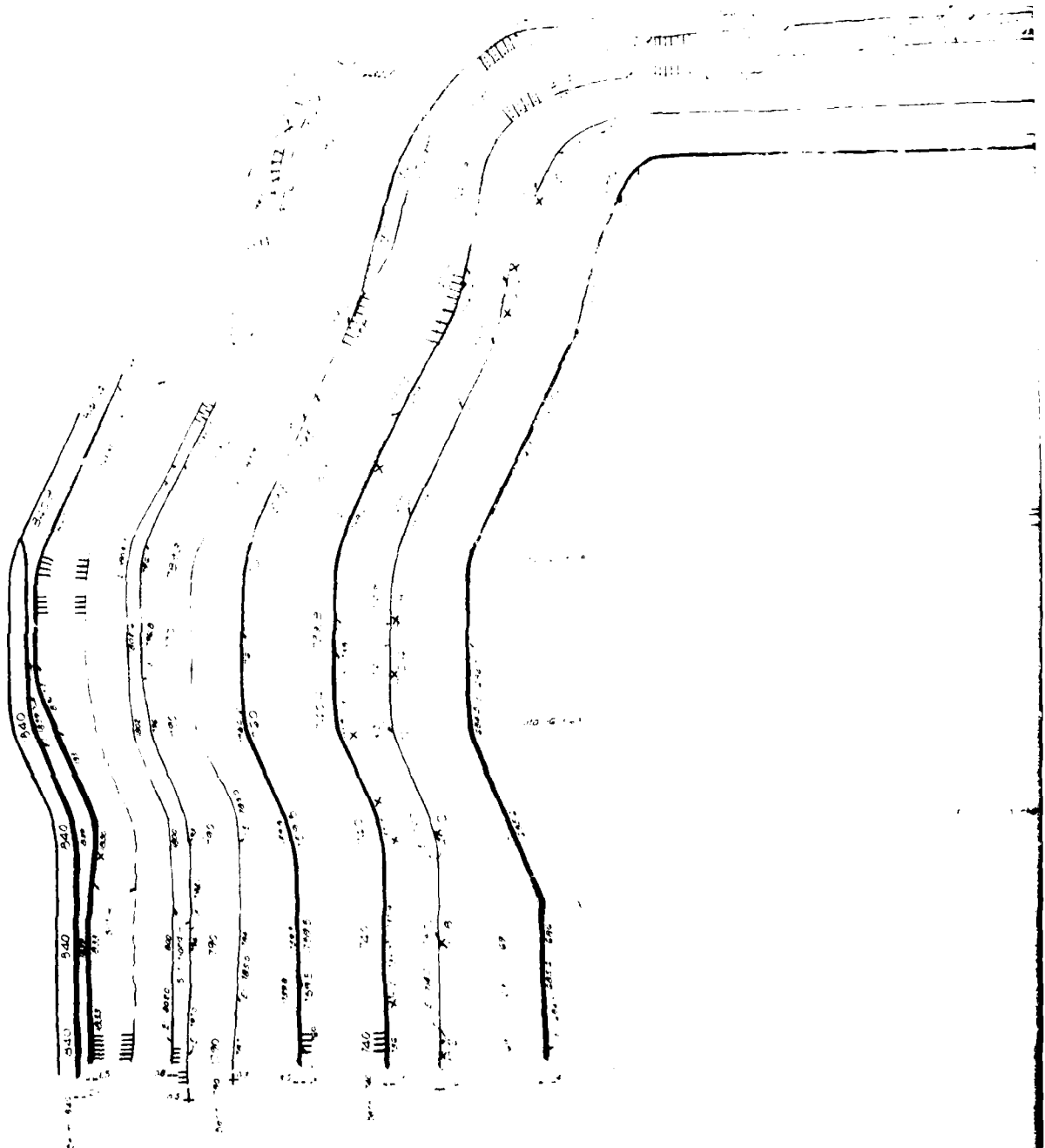
THIS PLAN ACCOMPANIES CONTRACT NO. DA-38-060-107 MODIFICATION NO.

DATE	DESCRIPTION	SCALE	APPROVED
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
MISSOURI RIVER		DATE MAY 1964	
GARRISON DAM AND RESERVOIR		SHEET NO. 66 OF 66	
UNDERSEEPAGE STUDIES		RELATIVE POSITION	
CONTOURS ON BOTTOM OF		WEST TERRACE GRAVEL	
DESIGNED BY C. J. J.	APPROVED <i>Charles E. Hogg</i>	DATE MAY 1964	
DRAWN BY S. A.	APPROVED <i>Shirley J. O'Connell</i>	SHEET NO. 66 OF 66	
TRACED BY S. A.	APPROVED	RELATIVE POSITION	
CHECKED BY S. A.	APPROVED	SHEET NO. 66 OF 66	
ENGINEER	APPROVED	RELATIVE POSITION	

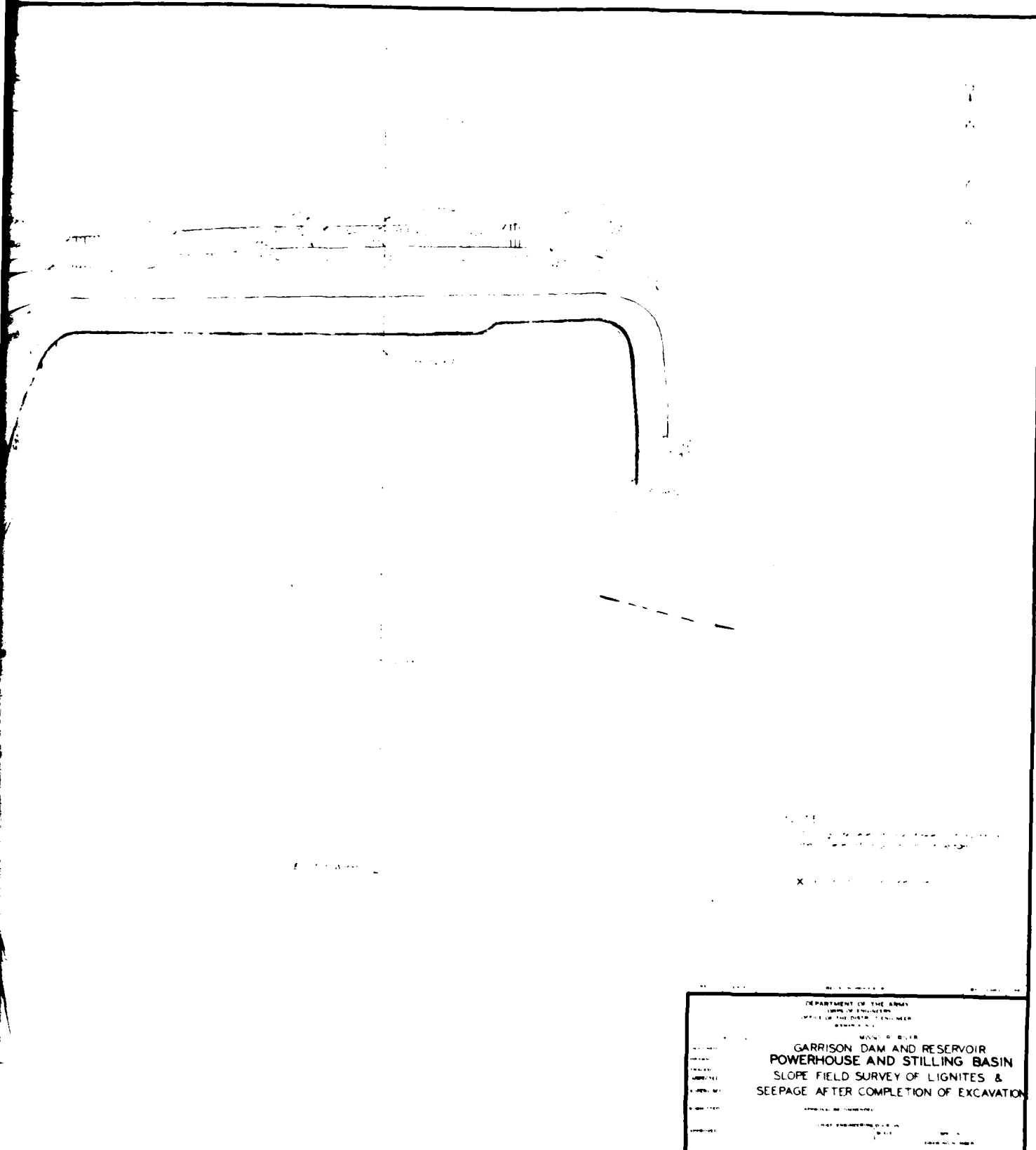
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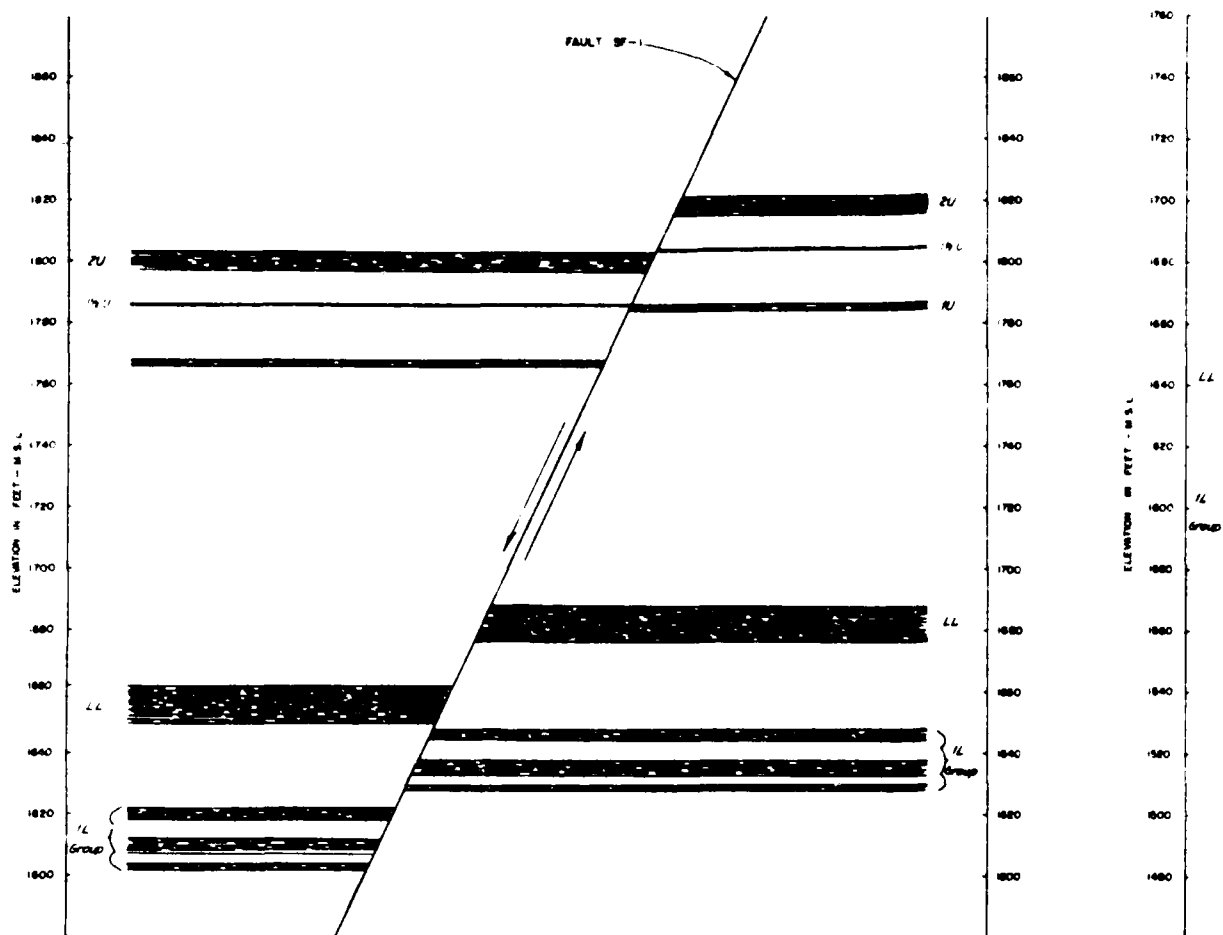




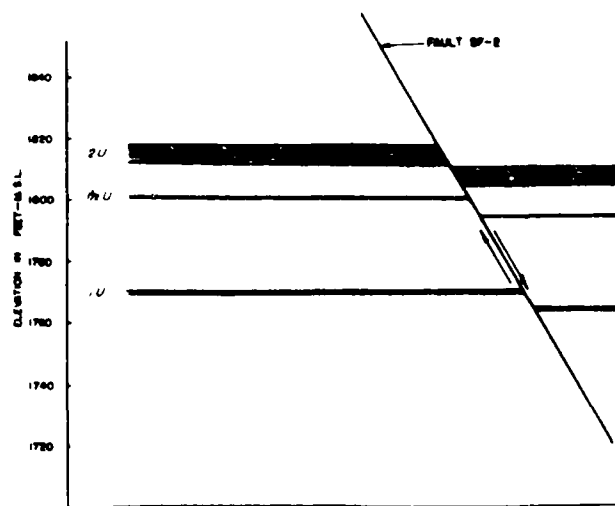




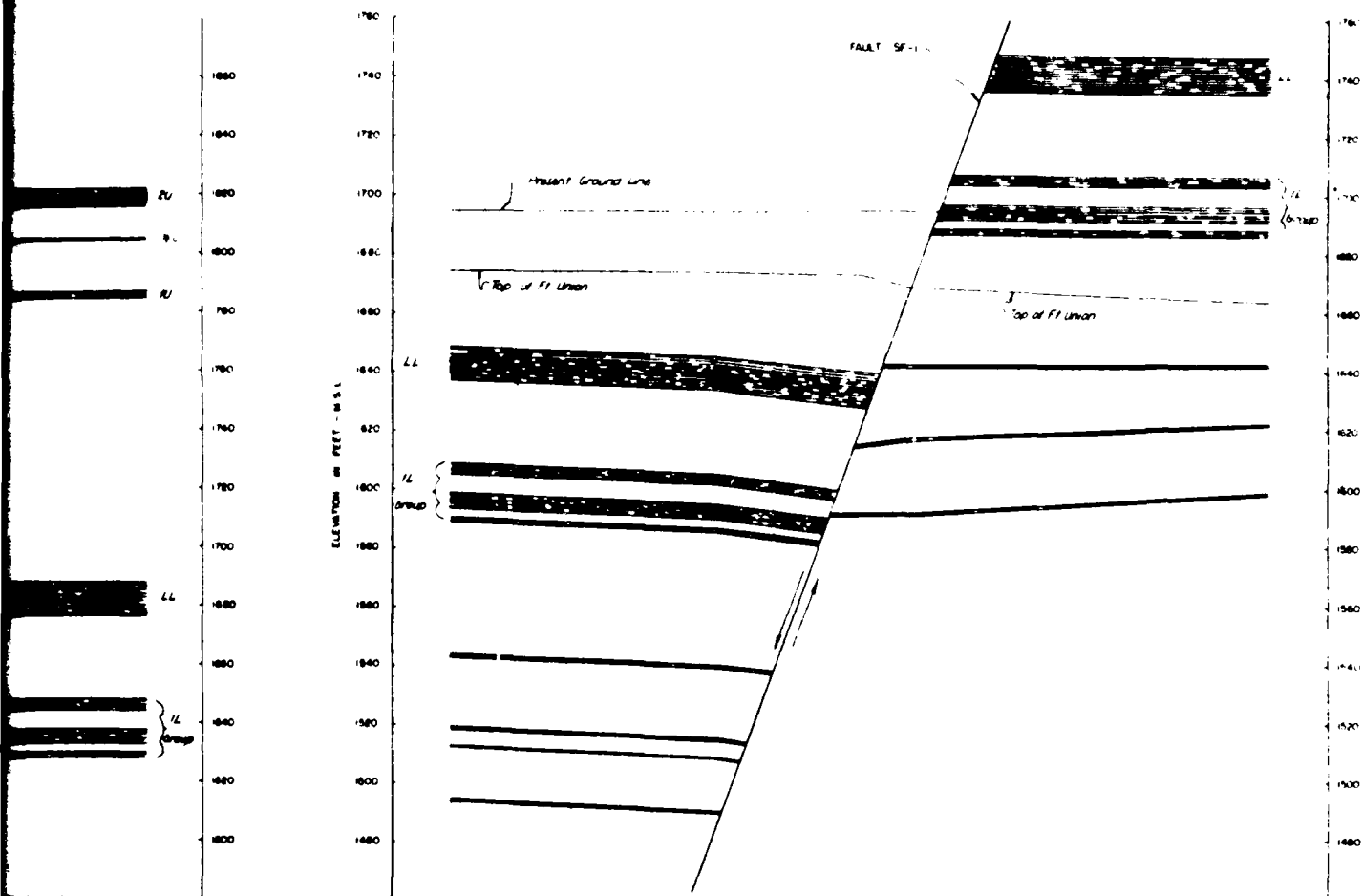
DEPARTMENT OF THE ARMY ENGINEER REGIMENT OFFICE OF THE DISTRICT ENGINEER WASHINGTON, D.C.	
MAJOR D. B. BAKER	
GARRISON DAM AND RESERVOIR POWERHOUSE AND STILLING BASIN SLOPE FIELD SURVEY OF LIGNITES & SEEPAGE AFTER COMPLETION OF EXCAVATION	
APPROVED BY DISTRICT ENGINEER	
APPROVED BY DISTRICT ENGINEER	



SECTION A-A  
SCALE VERT. 1"=20'  
HOR. 1"=20'

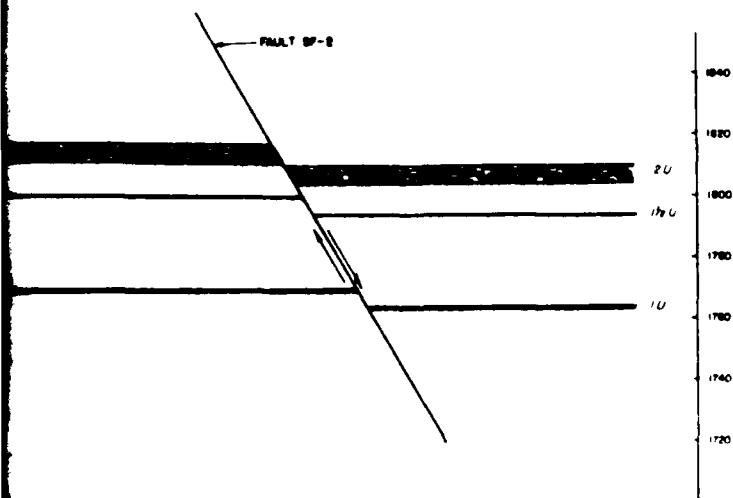


SECTION C-C  
SCALE VERT. 1"=20'  
HOR. 1"=20'



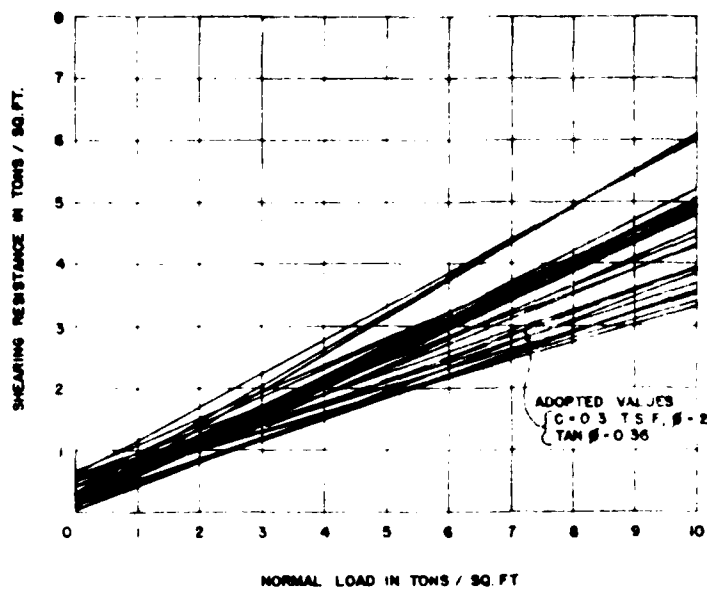
SECTION B-B  
 SCALE VERT 1"=20'  
 HOR 1"=20'

NOTES  
 For location of sections A-A and B-B see map GSK-5/37  
 For location of section C-C see map GSK-5/36

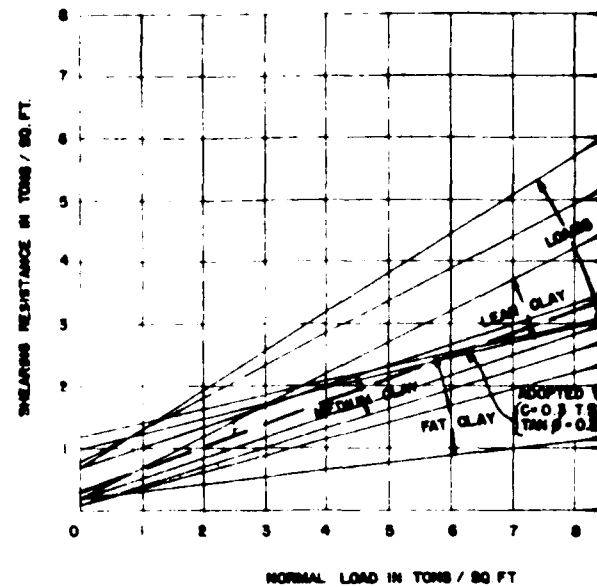


SECTION C-C  
 SCALE VERT 1"=20'  
 HOR 1"=20'

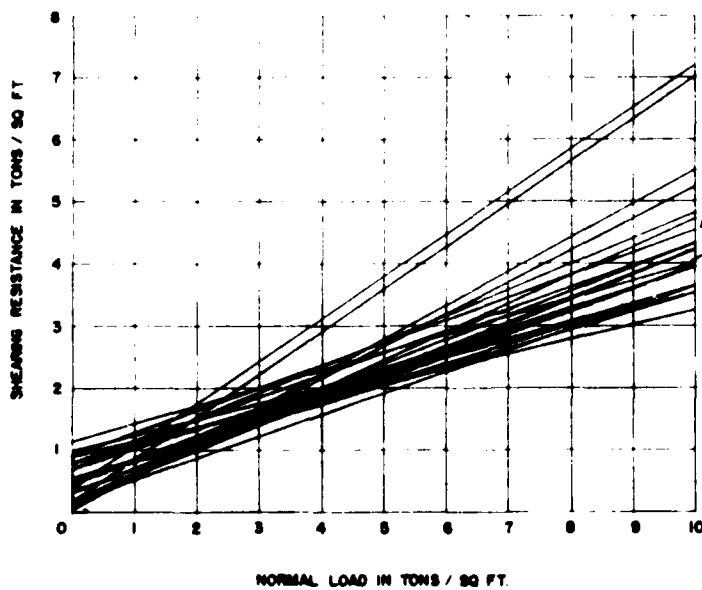
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY GENERALIZED GEOLOGIC SECTIONS MAJOR FAULTS	
APRIL 1952	GSK-5/56



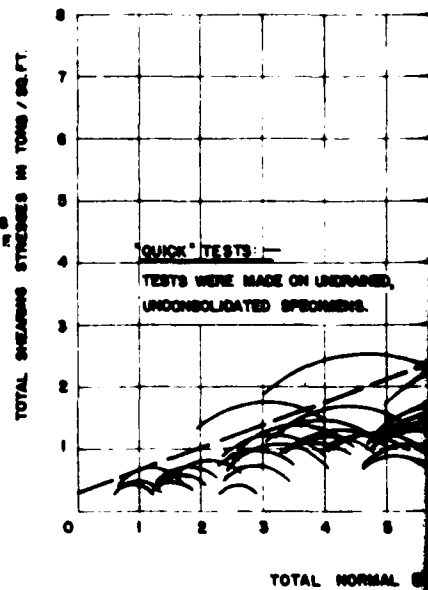
ALLUVIAL CLAY — DIRECT SHEAR TESTS  
FIGURE 1



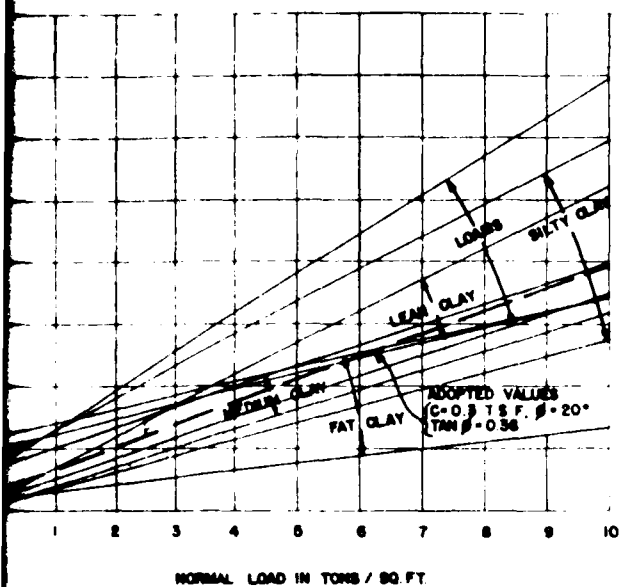
RANGES OF SHEAR STRENGTH FOR VARIOUS  
FROM DIRECT SHEAR TESTS — GLACIAL TILL &  
CLAYS  
FIGURE 2



GLACIAL TILL — DIRECT SHEAR TESTS  
FIGURE 4

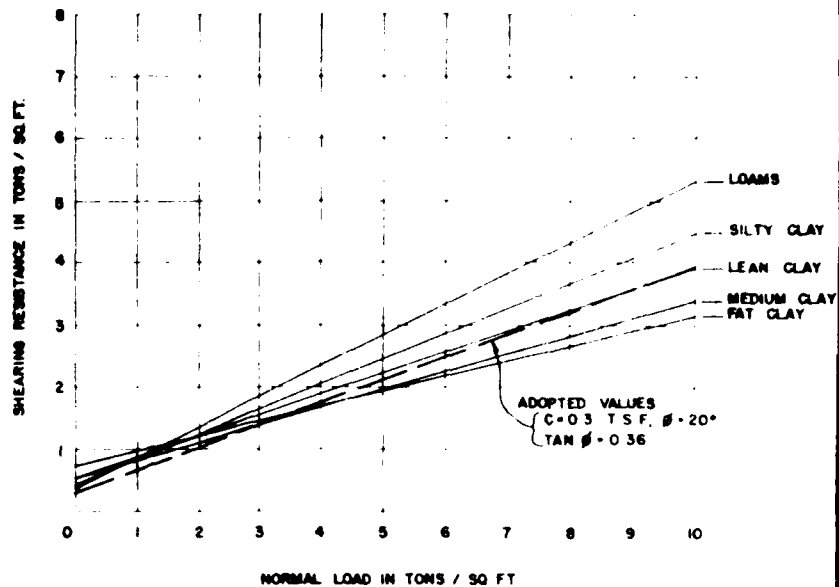


TRIAXIAL  
GLACIAL TILL



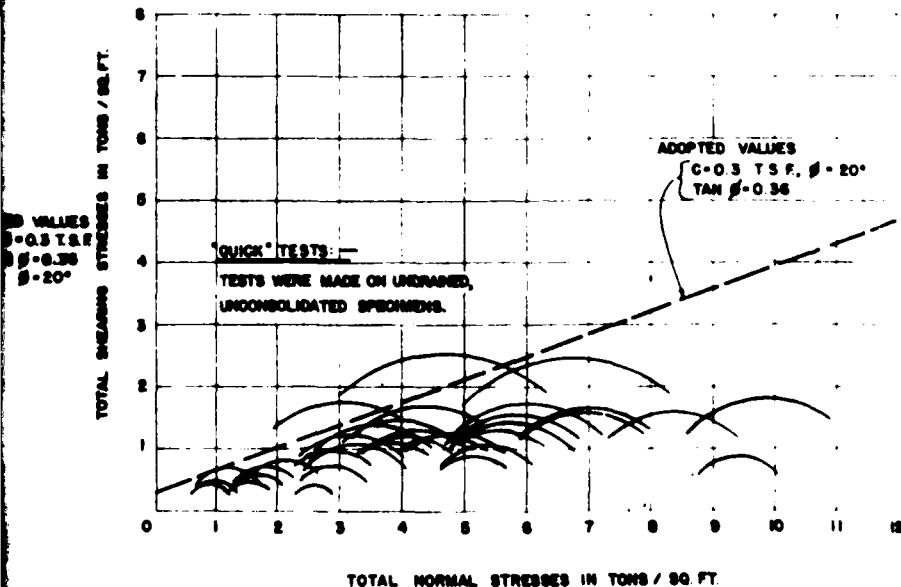
RANGES OF SHEAR STRENGTH FOR VARIOUS MATERIALS  
FROM DIRECT SHEAR TESTS - GLACIAL TILL & ALLUVIAL  
CLAYS

FIGURE 2



AVERAGE SHEAR STRENGTH FOR VARIOUS MATERIALS  
FROM DIRECT SHEAR TESTS - GLACIAL TILL & ALLUVIAL  
CLAYS

FIGURE 3



GLACIAL TILL & ALLUVIAL CLAYS

FIGURE 5

#### NOTES:

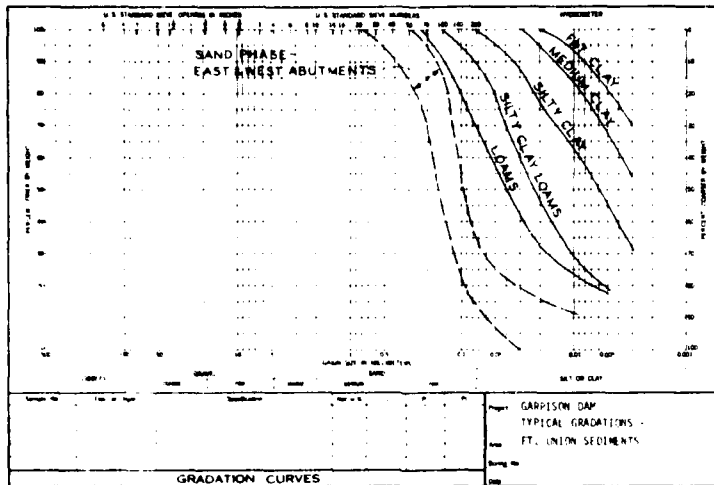
All tests made on undisturbed samples  
All direct shear test results are max-  
imum shear values

NOTE: From Analysis of Design, Excavation & Main  
Embankment, Stages I & II

REV	DATE	REVISION (Indicate by Δ)	BY
MISSOURI RIVER GARRISON DAM AND RESERVOIR GRAPHIC SUMMARIES OF SHEAR STRENGTH GLACIAL TILL & ALLUVIAL CLAYS			
MAY 1948		DRAWN BY CHECKED BY DESIGNED BY	

2



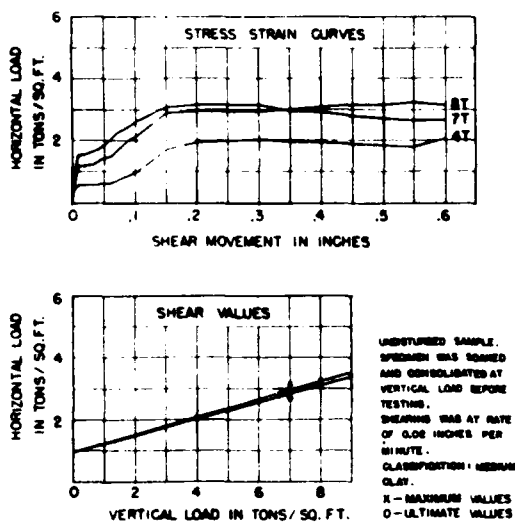


ENG. 1111, 2087

FIGURE 2

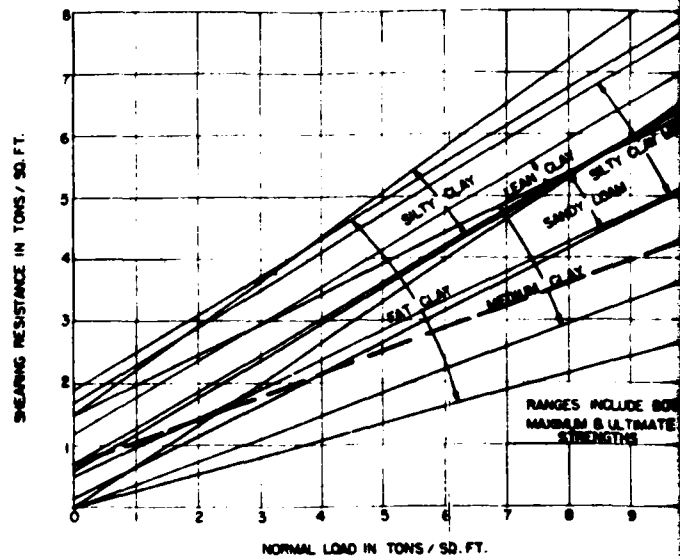
MISSOURI RIVER  
GARRISON DAM AND RESERVOIR  
TYPICAL GRADATIONS OF FOUNDATION SOILS,  
FORT UNION FM AND BORROW MATERIALS

U.S. ARMY ENGINEER DISTRICT, OMAHA  
CORPS OF ENGINEERS OMAHA, NEBRASKA



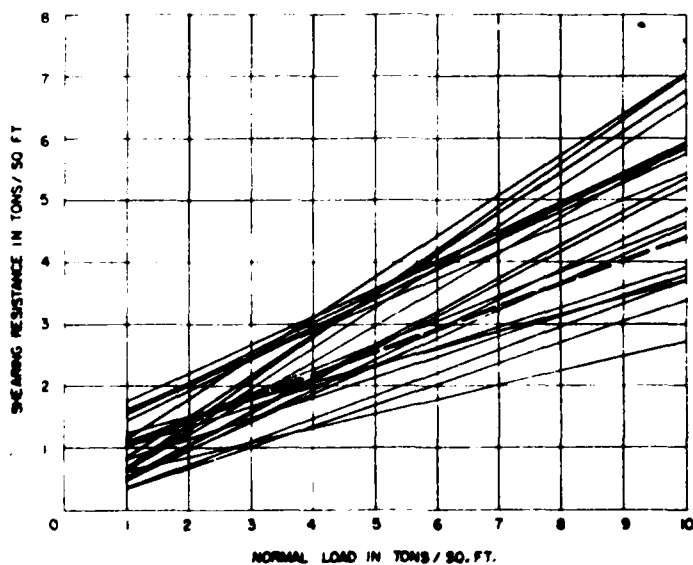
CONSTANT STRAIN DIRECT SHEAR TESTS

FIGURE 1



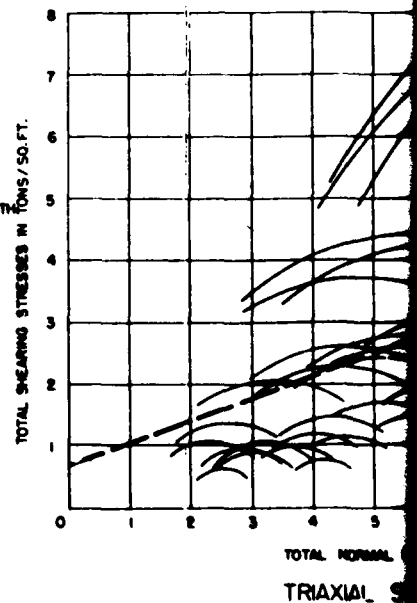
RANGES OF SHEAR STRENGTH FOR VARIOUS MATERIALS FROM DIRECT SHEAR TESTS

FIGURE 2



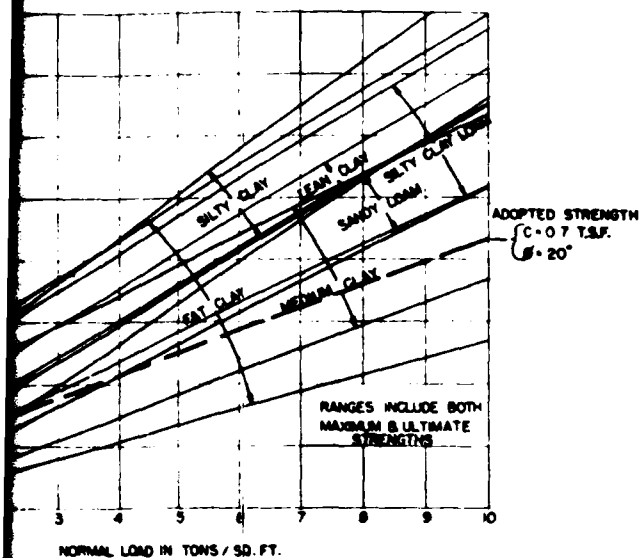
ULTIMATE STRENGTHS—CONSTANT STRAIN DIRECT SHEAR TESTS

FIGURE 4



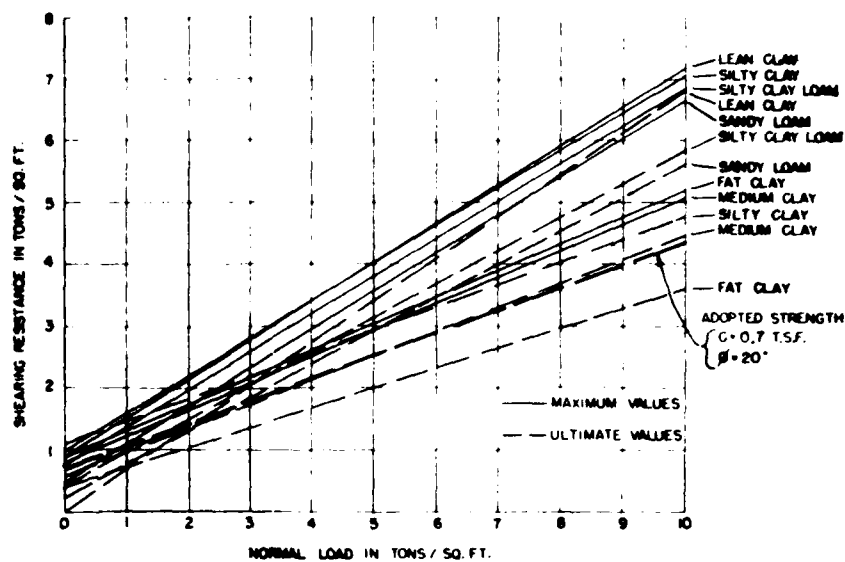
TOTAL NORMAL TRIAXIAL





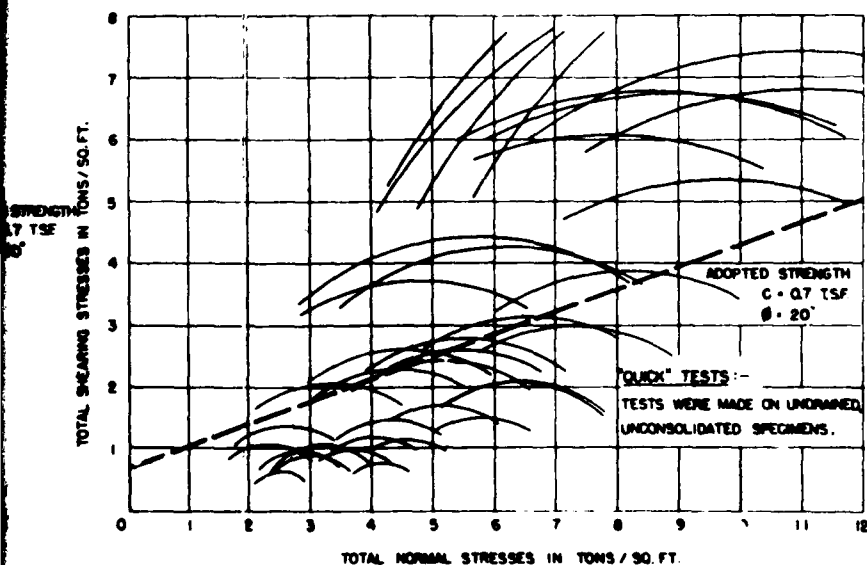
OF SHEAR STRENGTH FOR VARIOUS  
S FROM DIRECT SHEAR TESTS

FIGURE 2



AVERAGE SHEAR STRENGTH FOR VARIOUS  
MATERIALS FROM DIRECT SHEAR TESTS

FIGURE 3

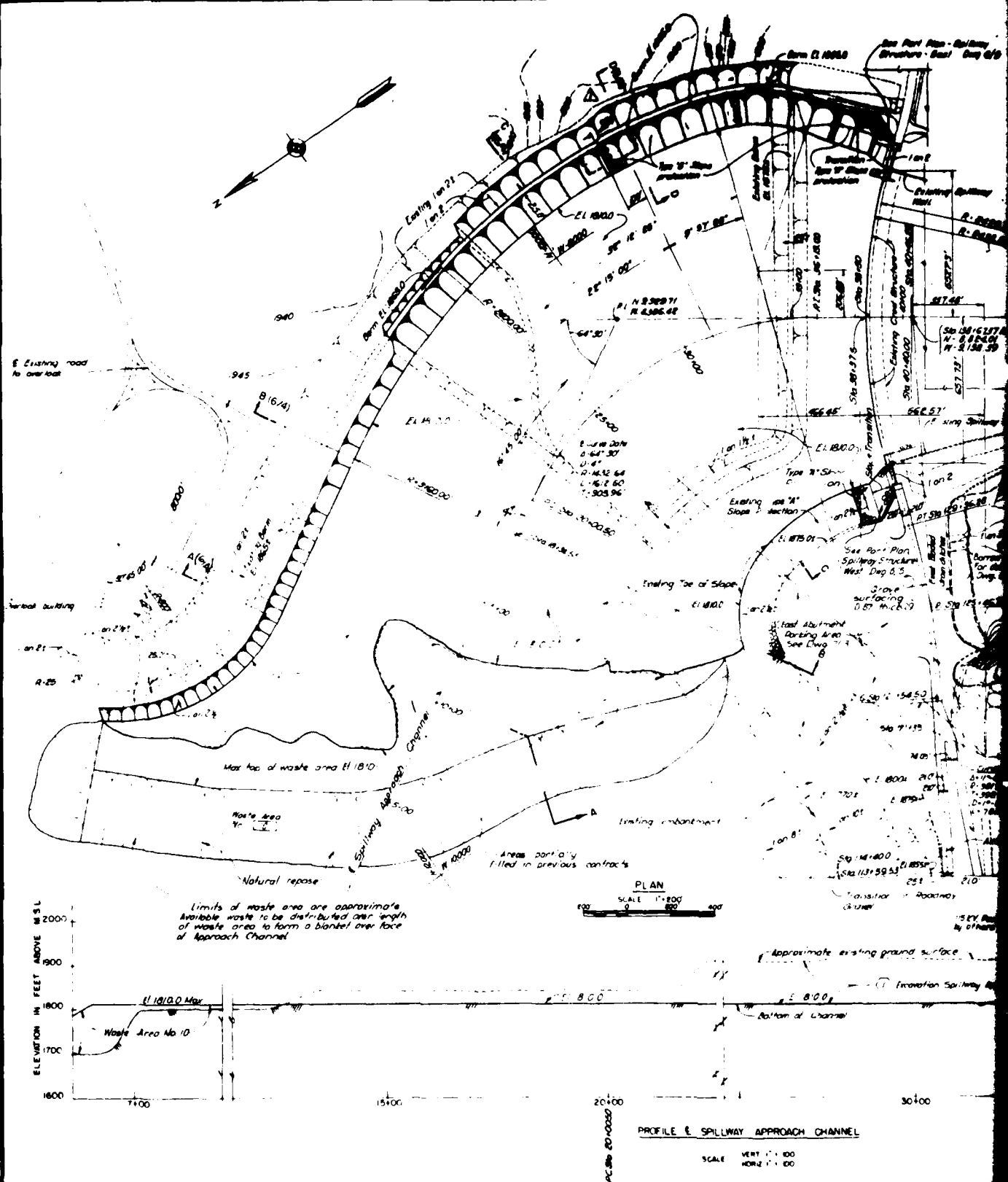


TRIAxIAL SHEAR TESTS  
FIGURE 5

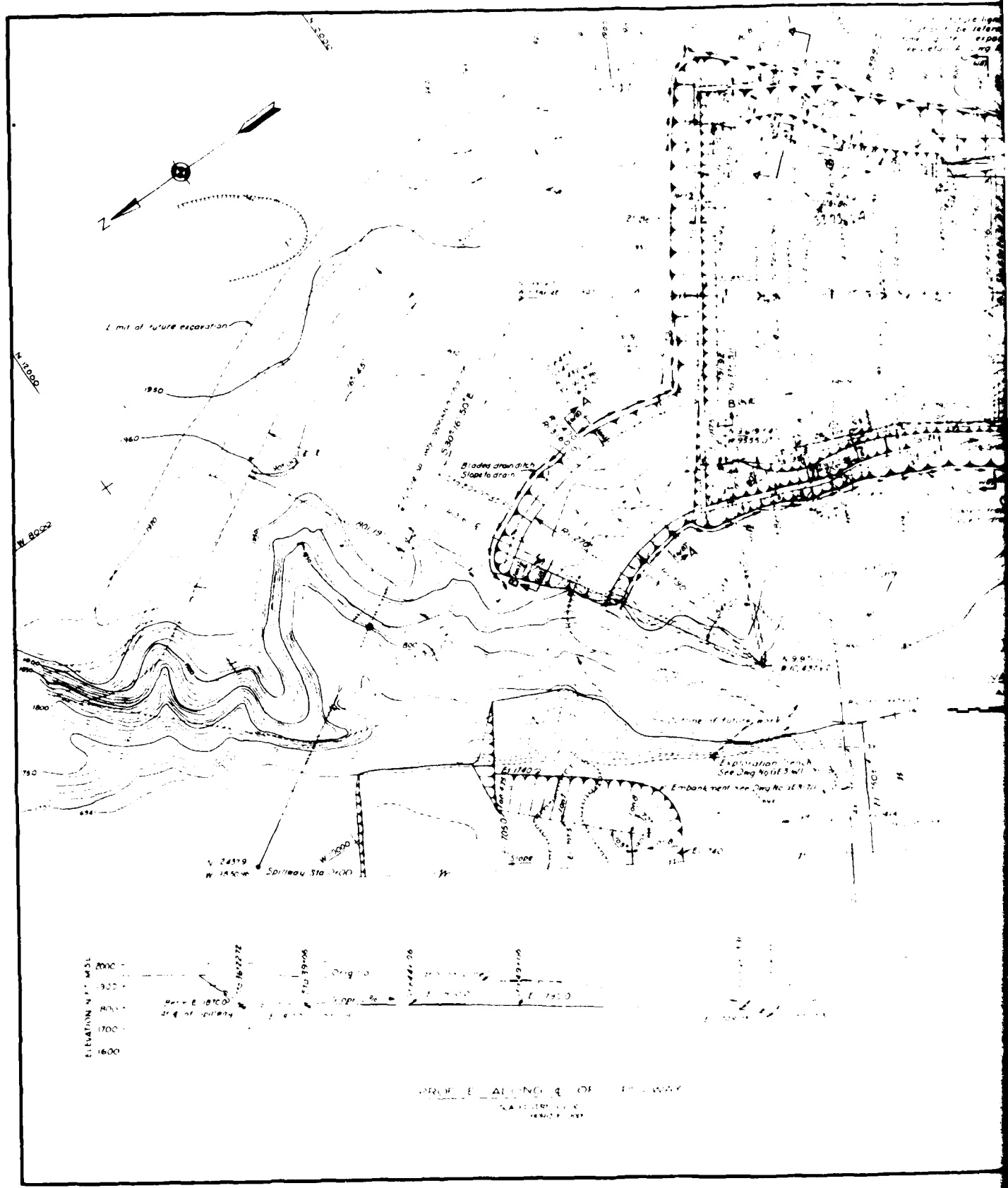
NOTE : All tests made on undisturbed samples

NOTE: From Analysis of Design, Excavation & Main  
Embankment, Stages I & II

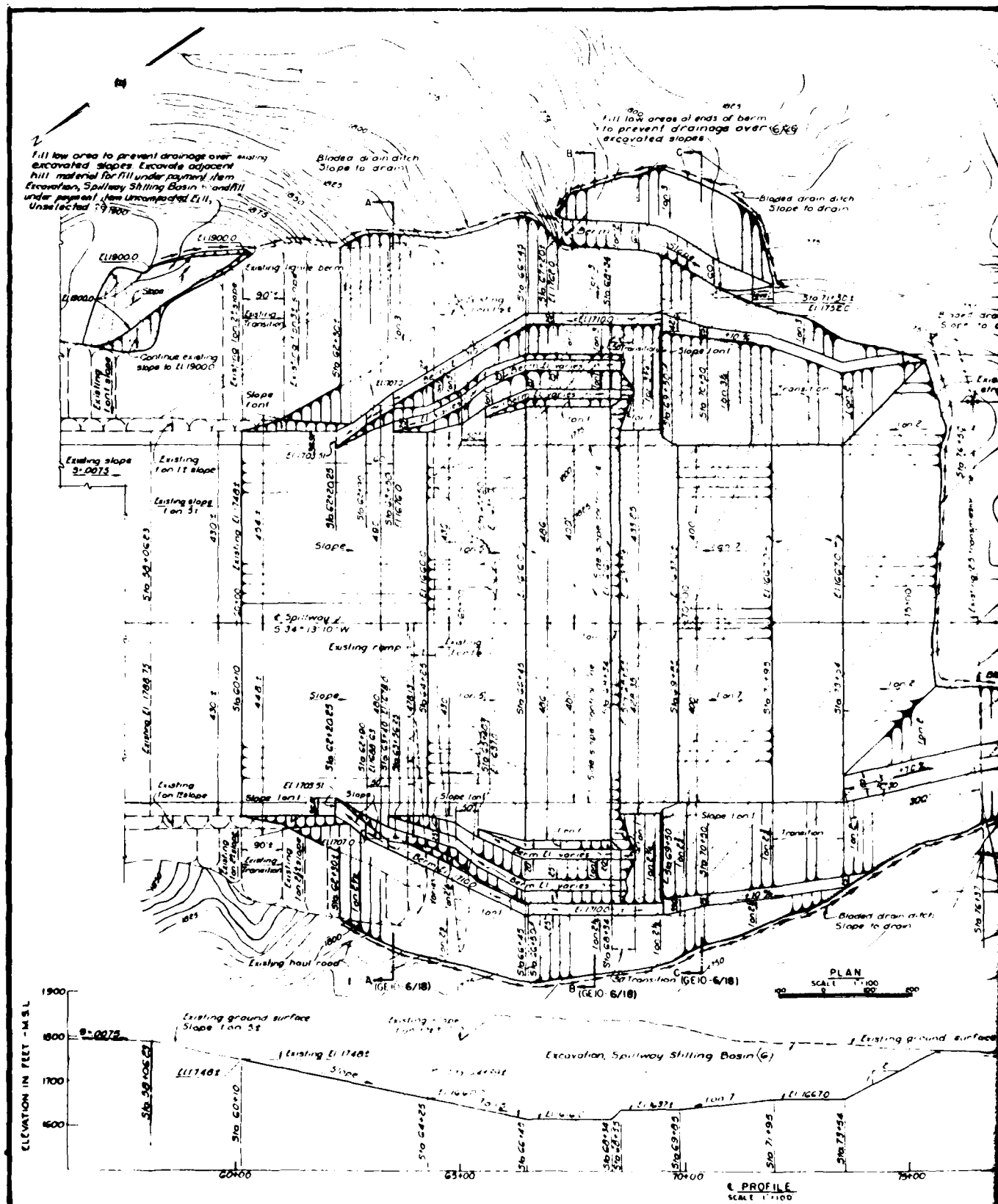
REV	DATE	REVISION (Indicated by Δ)	BY
MISSOURI RIVER U.S. DEPARTMENT OF COMMERCE OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.			
GARRISON DAM AND RESERVOIR GRAPHIC SUMMARIES OF SHEAR STRENGTH - FORT UNION			
MAY 1948		GEX 7719	

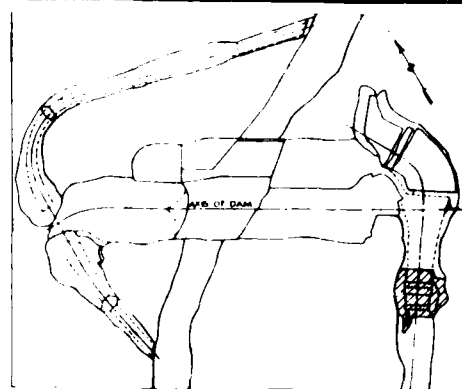
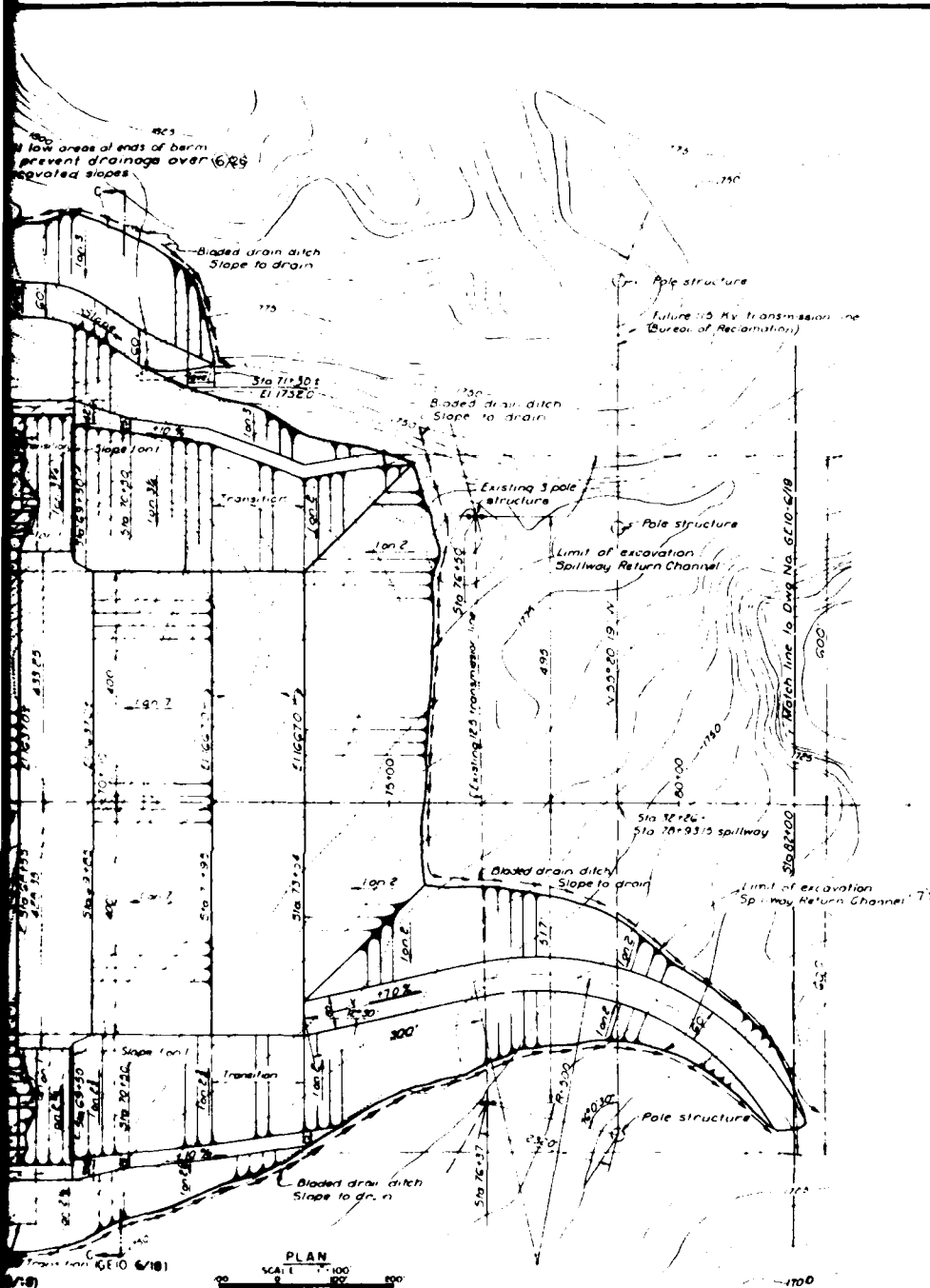








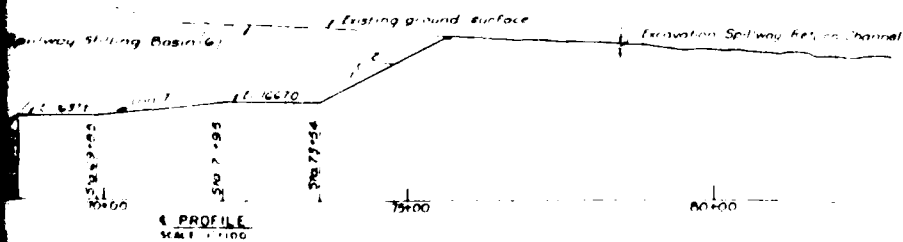




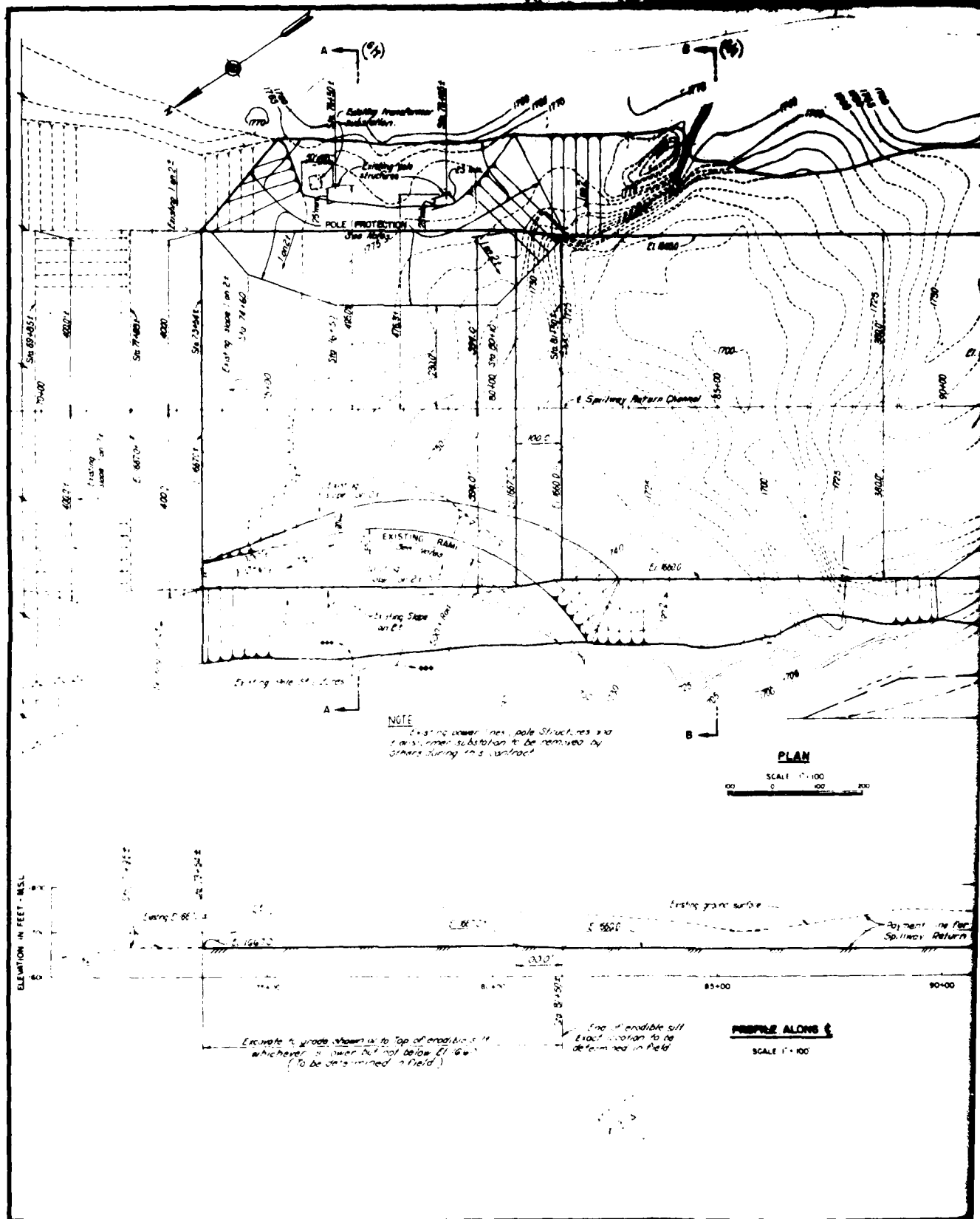
KEY PLAN

#### NOTES

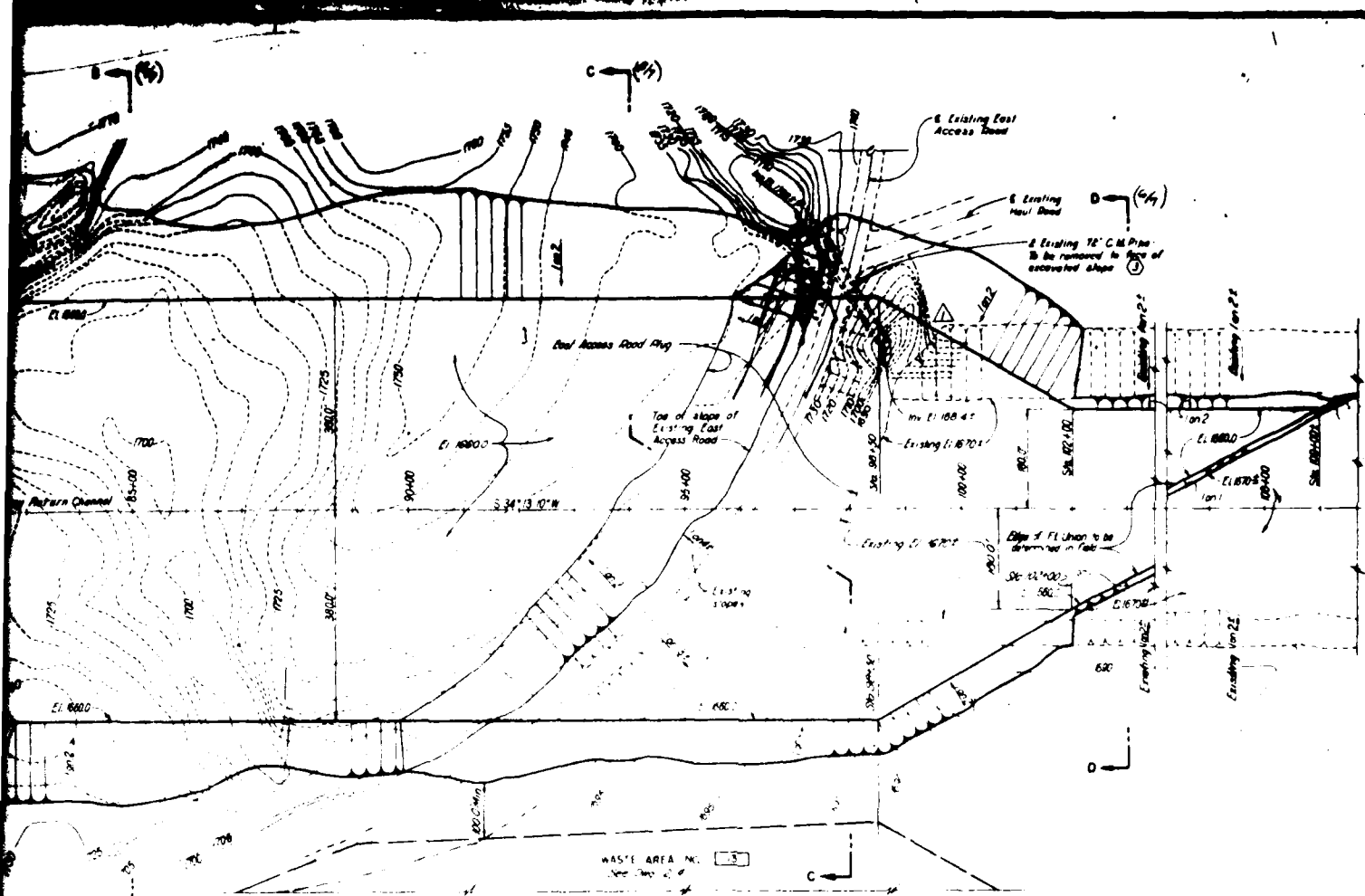
Figures in hexagons indicate item number under which payment will be made.  
 For Last Abutment Plan, see Dwg No. GE10-6/12.  
 For Spillway Approach Channel Plan, see Dwg No. GE10-6/15.  
 For General Plan, see Dwg No. GE10-6/14.  
 All excavation shown in this drawing will be paid for under item No. 6, Excavation Spillway Stilling Basin, except as noted.  
 For Foundation Excavation, Spillway Stilling Basin, see Dwg No. GE10-6/17.



REV.	DATE	BY	CHKD.	APP.
1	8/1/34	J. H. B.	J. H. B.	J. H. B.
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MISSOURI RIVER GARRISON DAM AND RESERVOIR DAM EMBANKMENT SPILLWAY STILLING BASIN PLAN AND PROFILE AUGUST 1934 GE10-6/17				

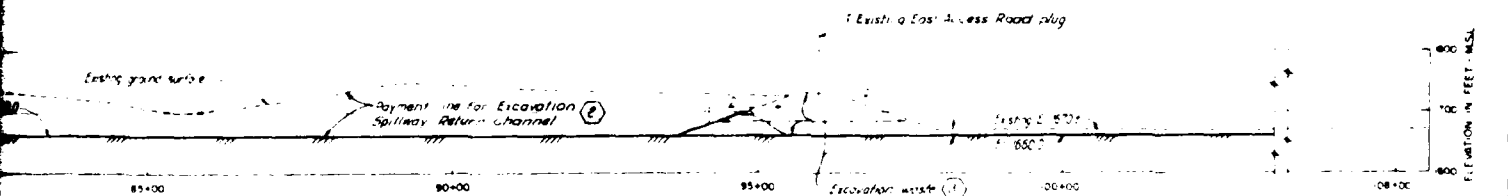






# PLAN

SCALE 1" = 100'



at probable sill  
position to be  
used in field

## PROFILE ALONG C

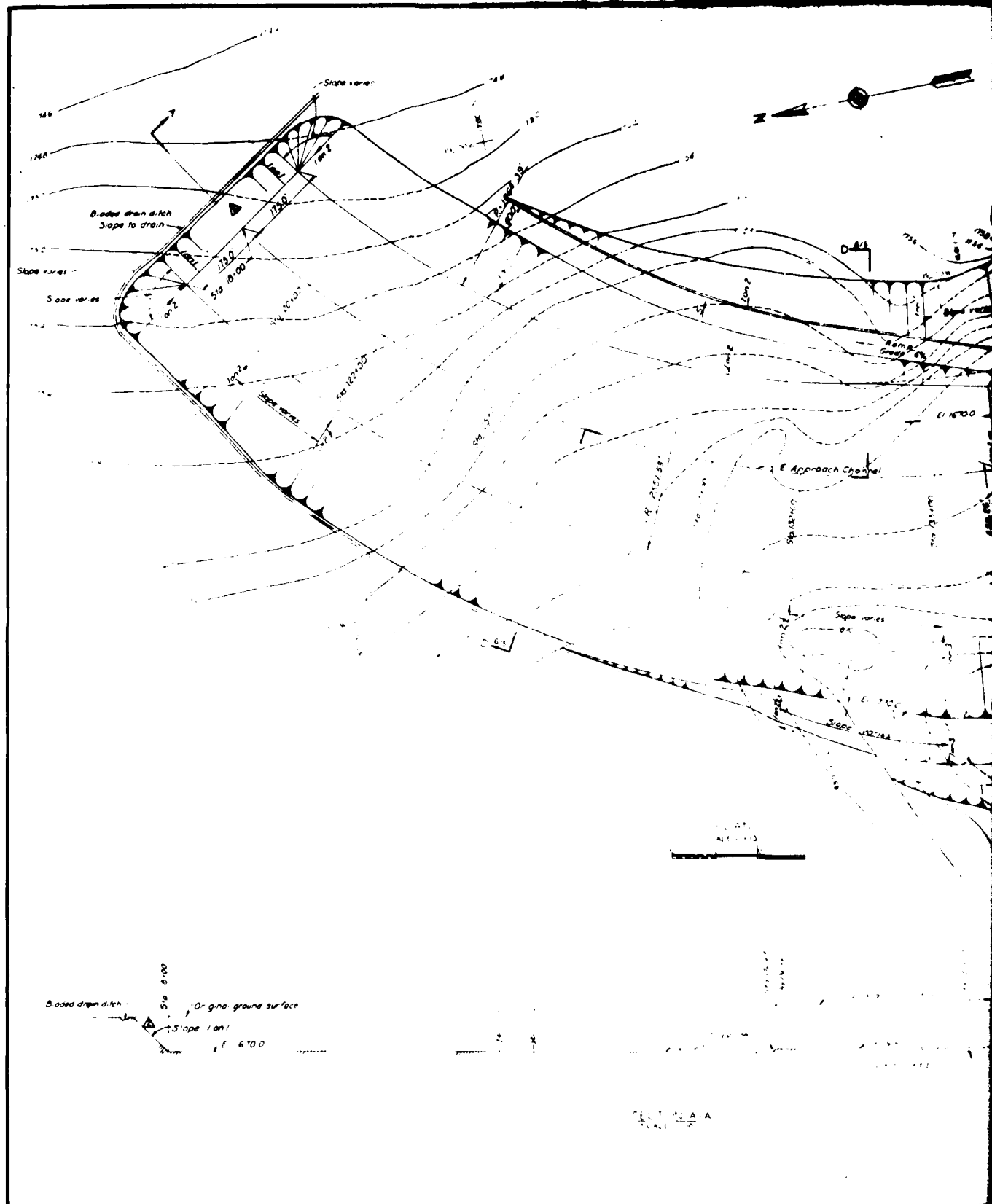
SCALE 1" = 100'

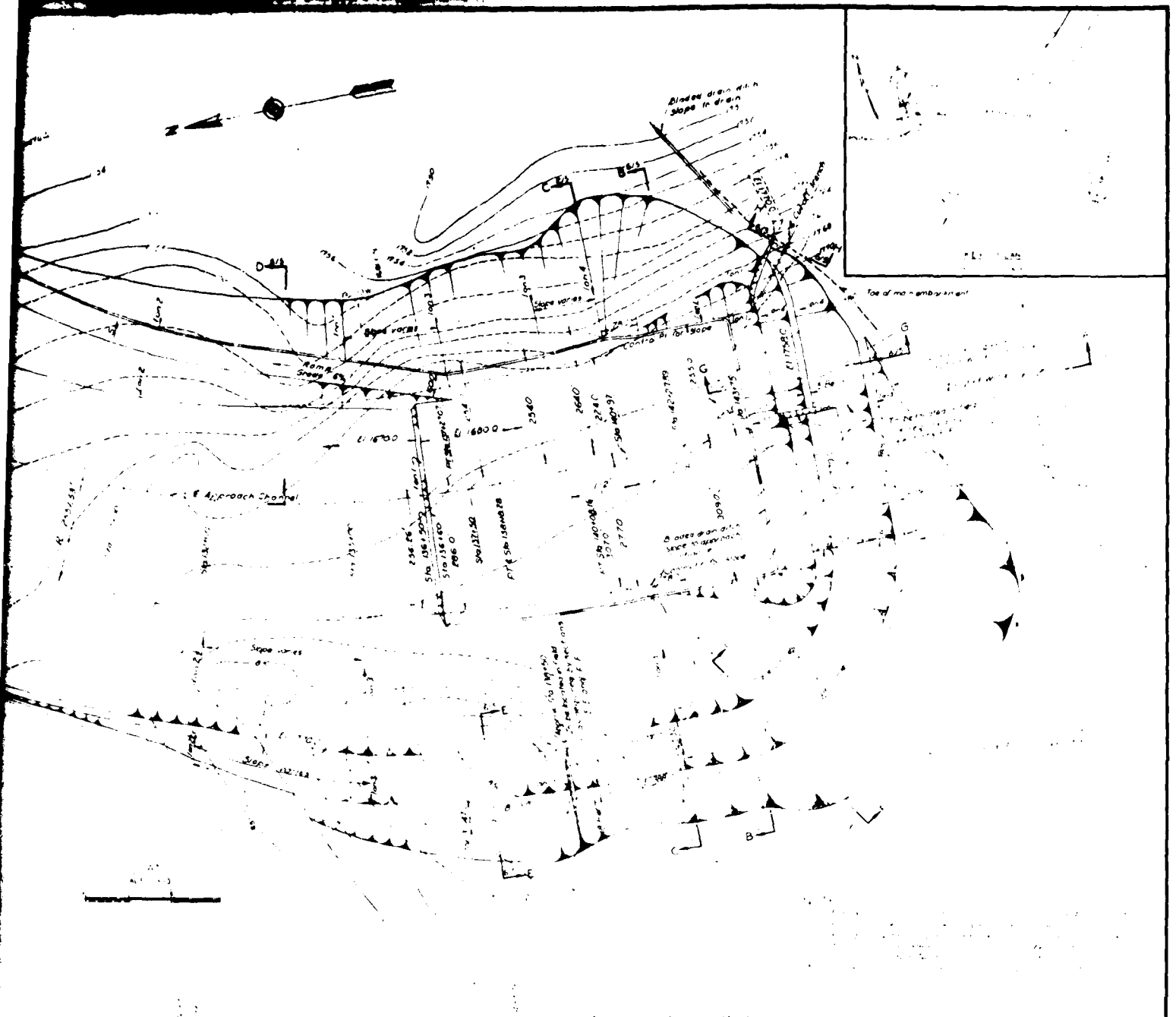
### NOTES

- Figures in hexagons indicate item numbers under which payment will be made for General Plan see Dig 2'd for Foundation Excavation for Spillway and Sections A & B to D include see Dig 6't for Excavation of existing spillway, dam, and East Access Road plug will be paid for under payment item 3 Excavation waste

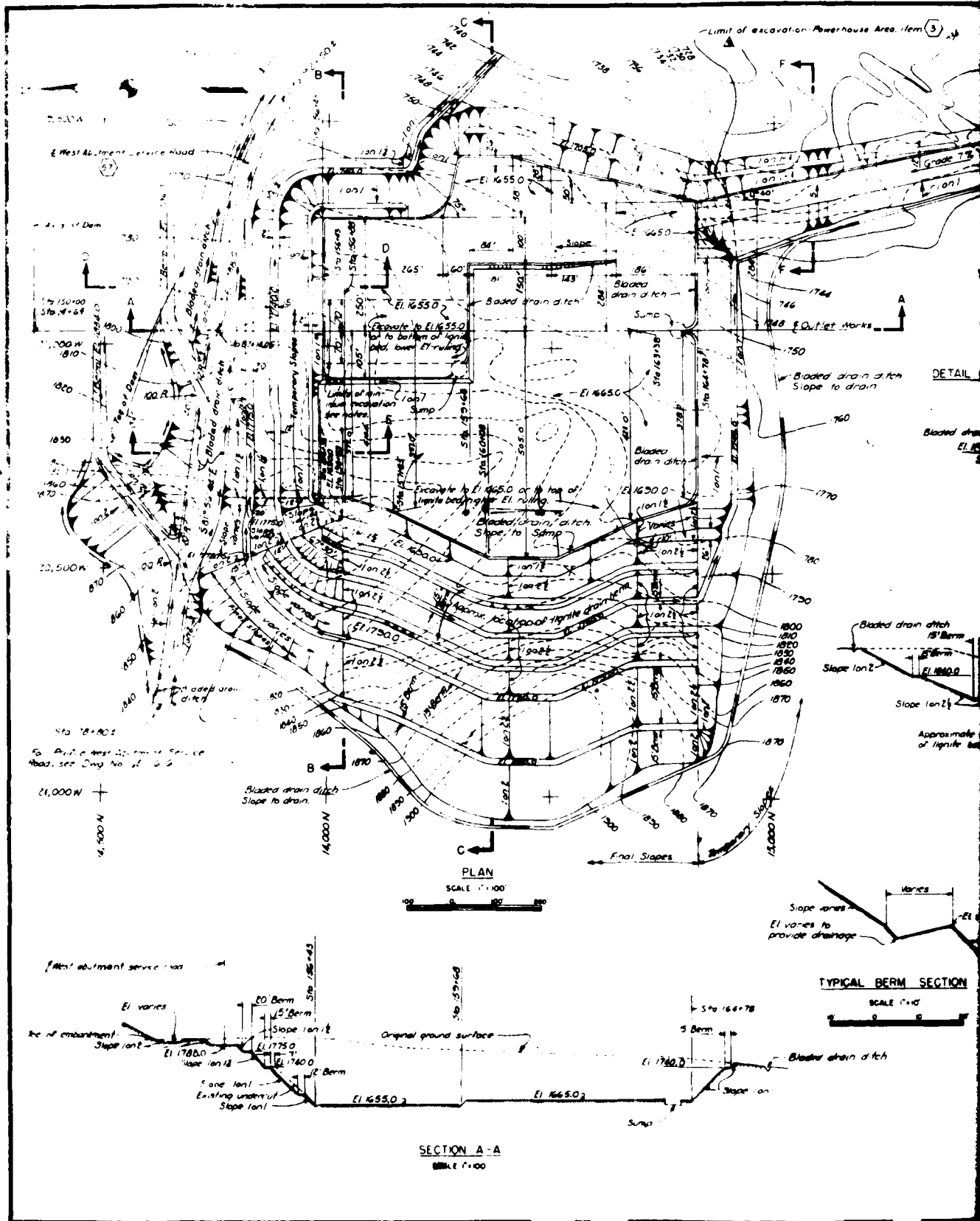
1	9-1-53	Revised prior to advertising	REVISION
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DISTRICT NO. 8			
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY RETURN CHANNEL EXCAVATION PLAN AND PROFILE			
<p>APPROVED</p> <p>BY <i>[Signature]</i></p>			<p>AUGUST 1953</p> <p>GE 17-6/6</p>

2

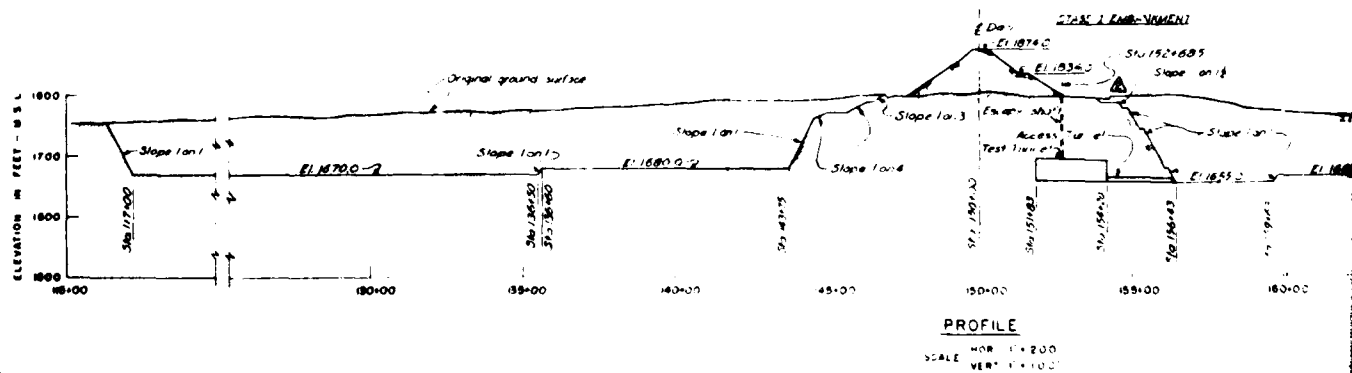
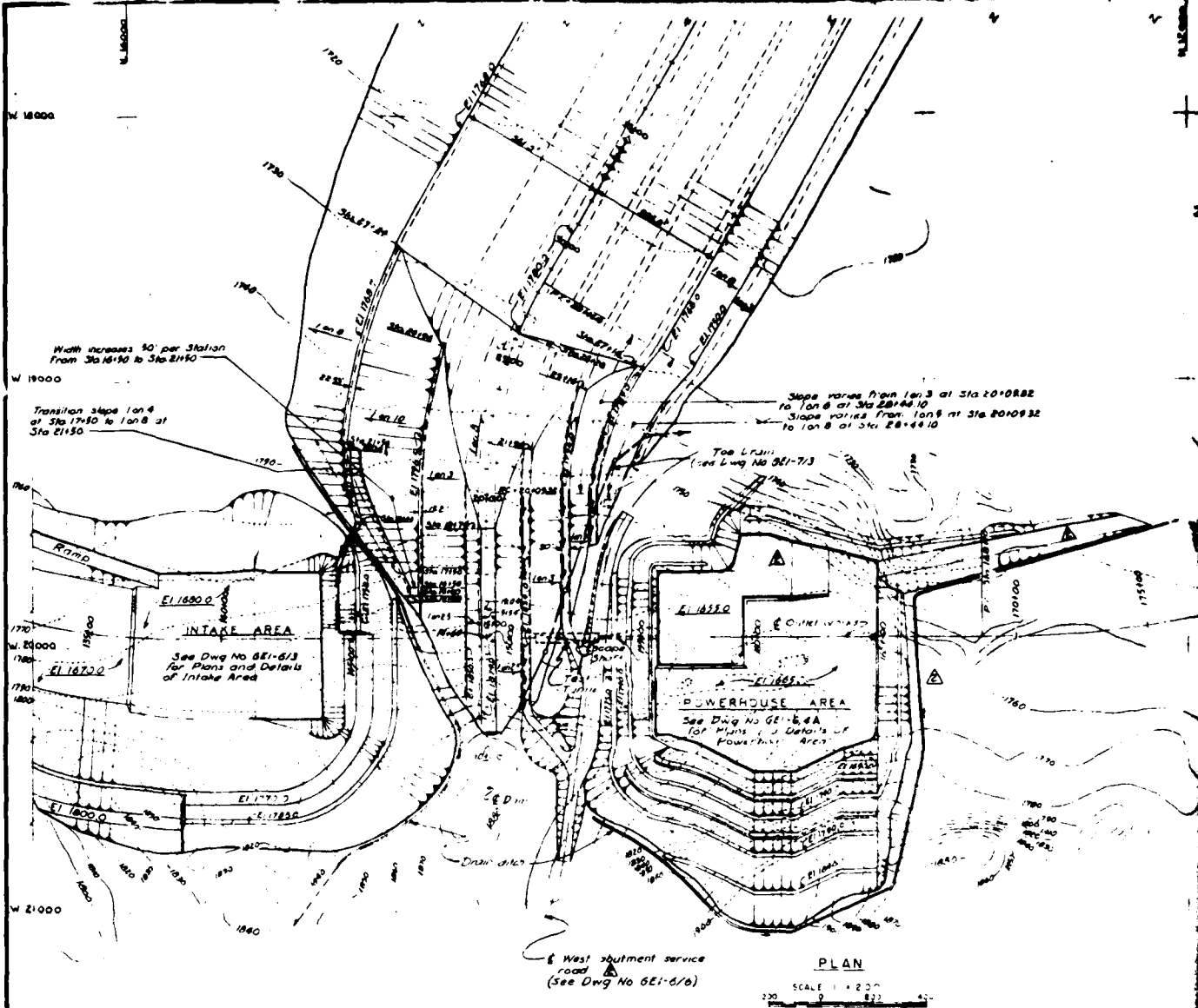


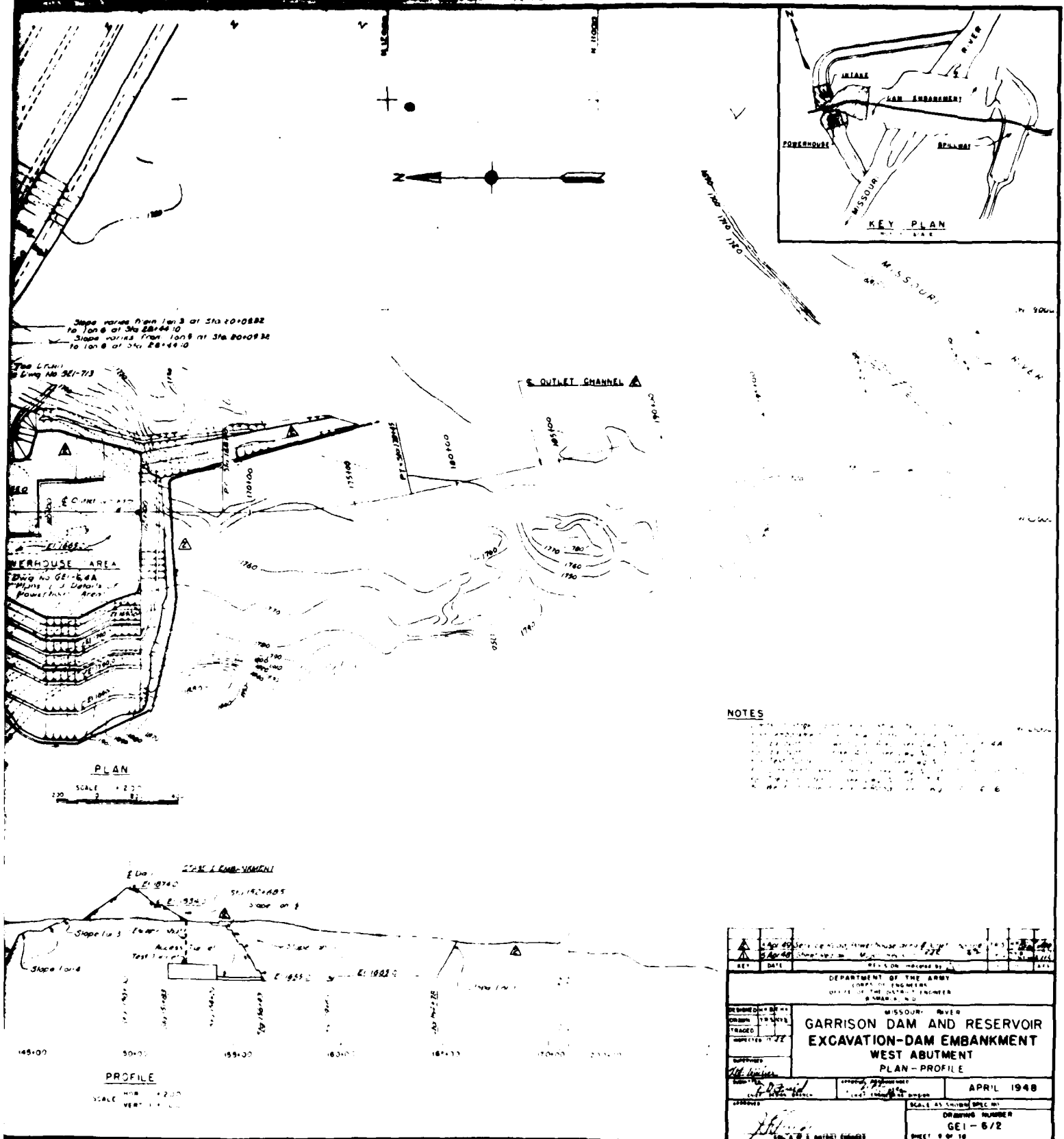


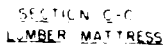
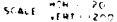
REV.	DATE	REVISIONS INDICATED BY
1	APRIL 1948	
MISSOURI RIVER CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER D-SMARCH, MO.		
GARRISON DAM AND RESERVOIR EXCAVATION INTAKE AREA PLAN AND SECTION		
DESIGNED BY	APPROVED BY	DATE
TRAFFIC		APRIL 1948
REVIEWED BY		
SCALE	SPEC. NO.	
ORIGINATING NUMBER	GEI-6/3	











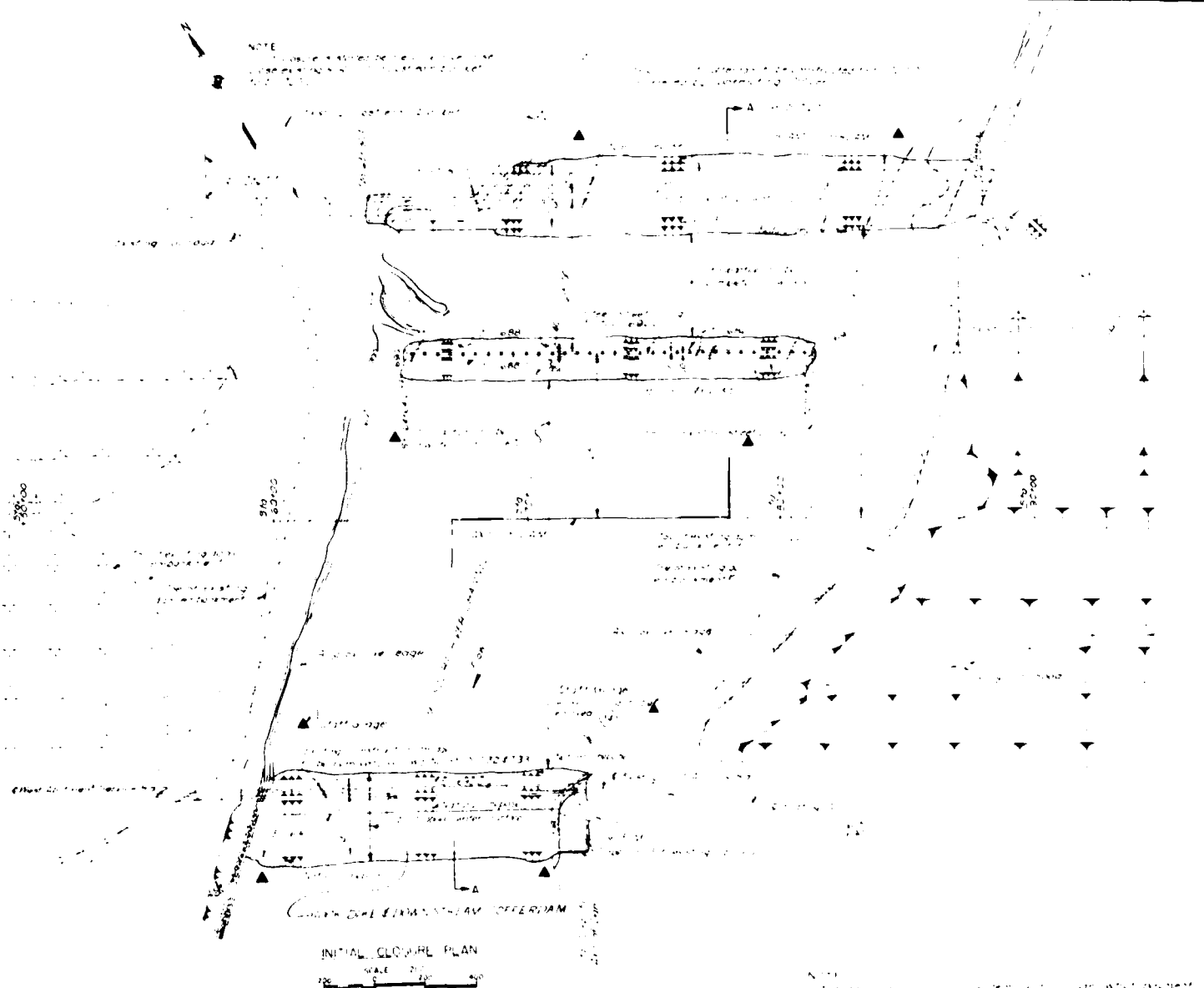
NOTE

closure is started before July 15th and is completed by August 1st.

INITIAL CLOSURE

4. (A, B)  $\rightarrow$  C



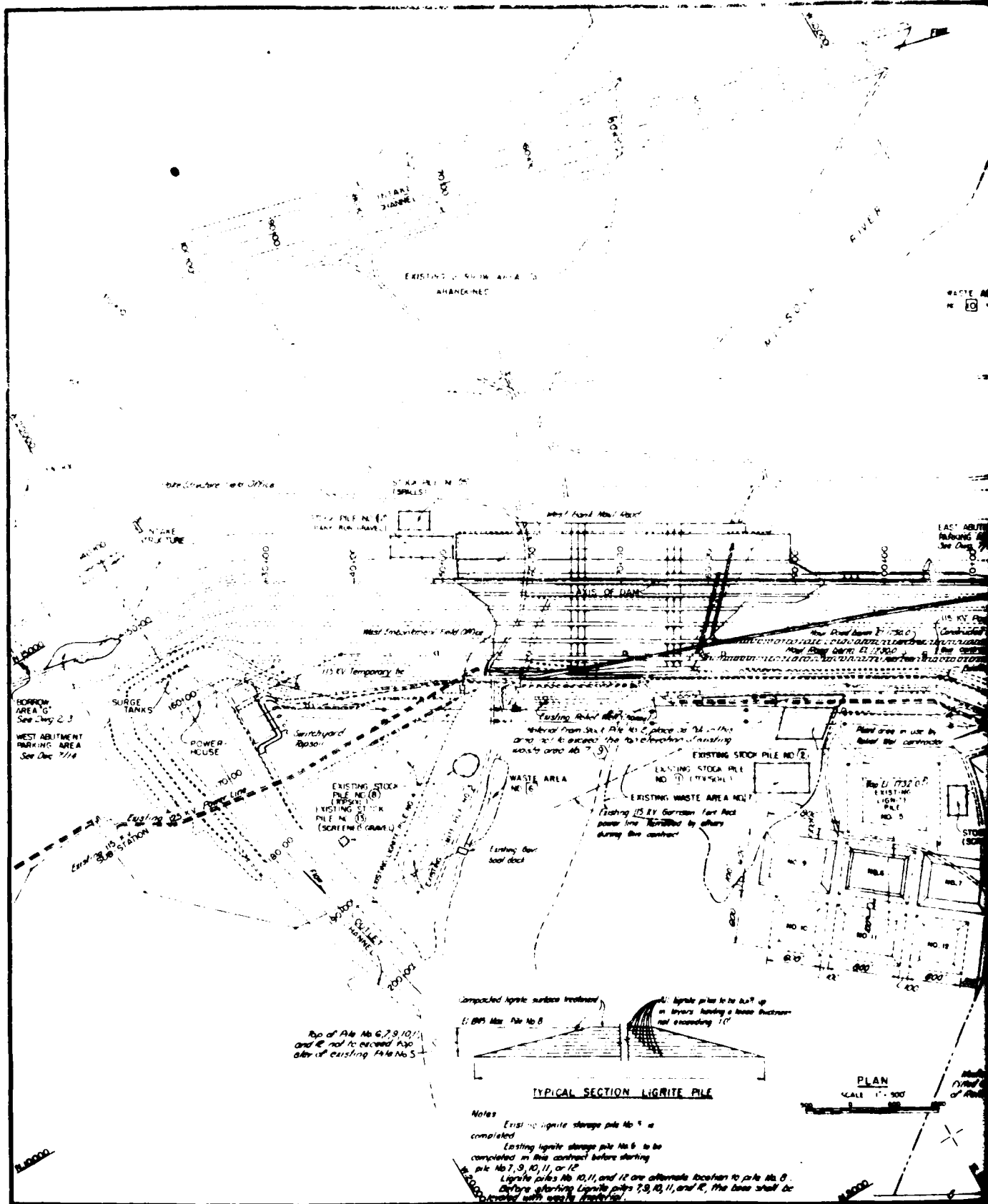


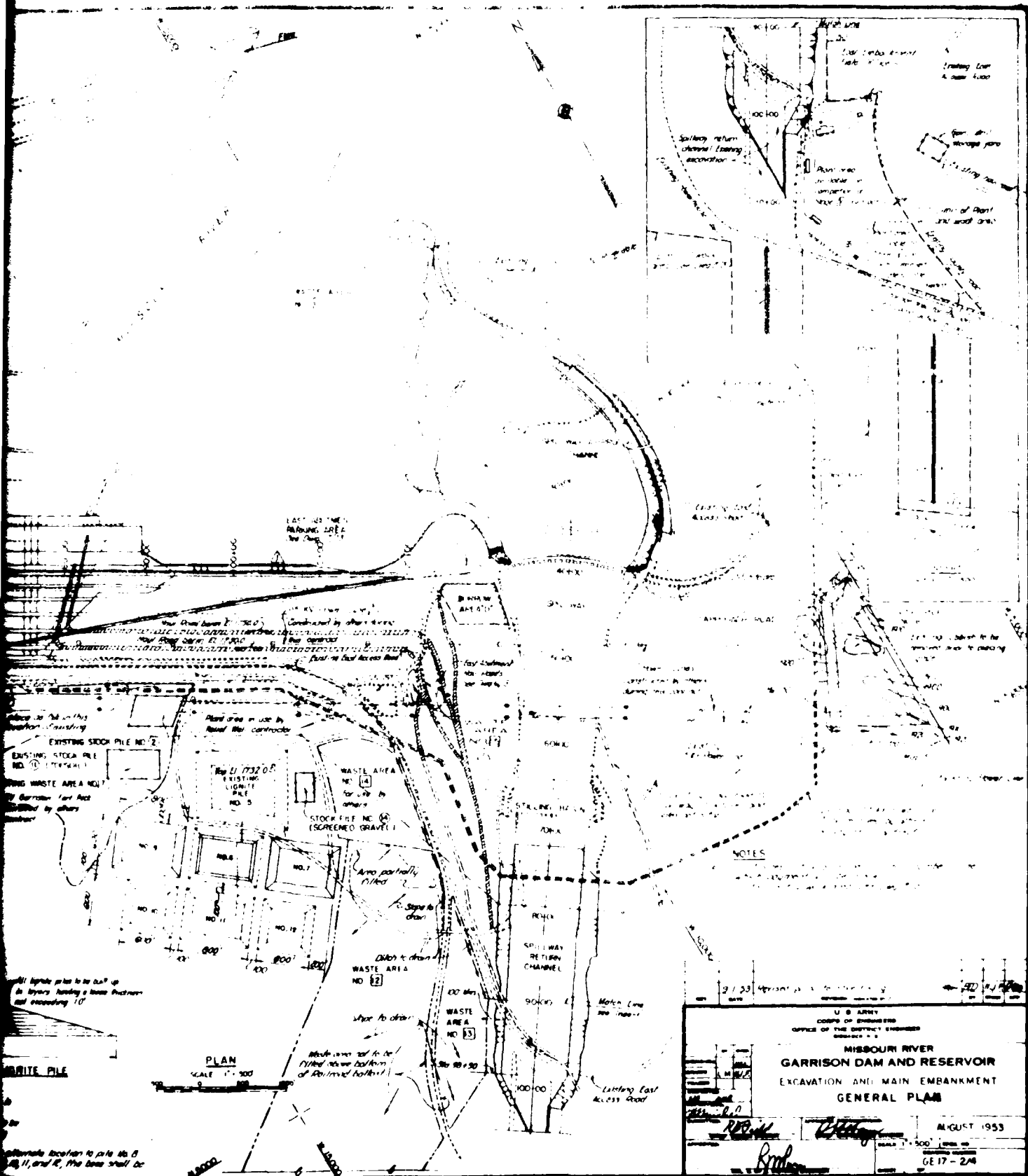
NOTE: This plan is a preliminary sketch and is not to be used for construction purposes without the approval of the District Engineer.

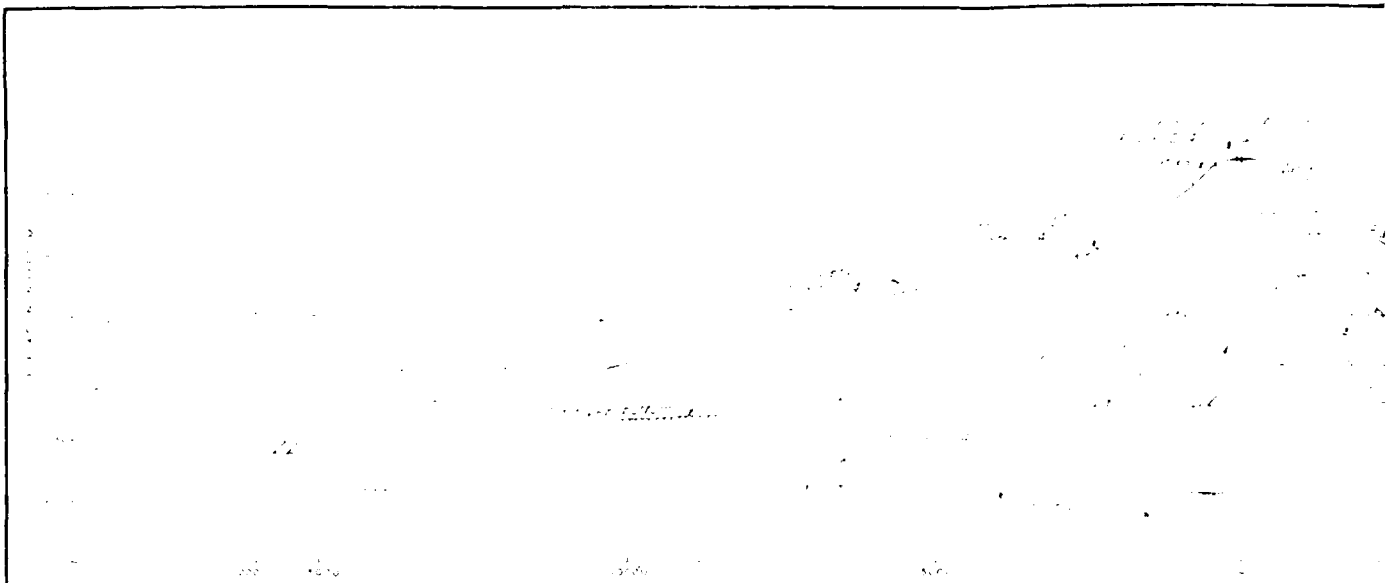
DESIGNED BY: [Signature]  
 DRAWN BY: [Signature]  
 CHECKED BY: [Signature]  
 APPROVED BY: [Signature]  
 DATE: [Date]

U. S. ARMY  
 CORPS OF ENGINEERS  
 OFFICE OF THE DISTRICT ENGINEER  
 MISSOURI RIVER  
 GARRISON DAM AND RESERVOIR  
 LOW EMBANKMENT  
 INITIAL CLOSURE  
 SCALE: 1" = 100'

APPROVED BY: [Signature]  
 DATE: [Date]







SECTION  
STA 70+00



SECTION  
STA 40+00

SECTION  
STA 70+00

SECTION  
STA 40+00



THIS PLAN ACCOMPANIES CONTRACT NO.  
DA-36-066-40 MODIFICATION NO.

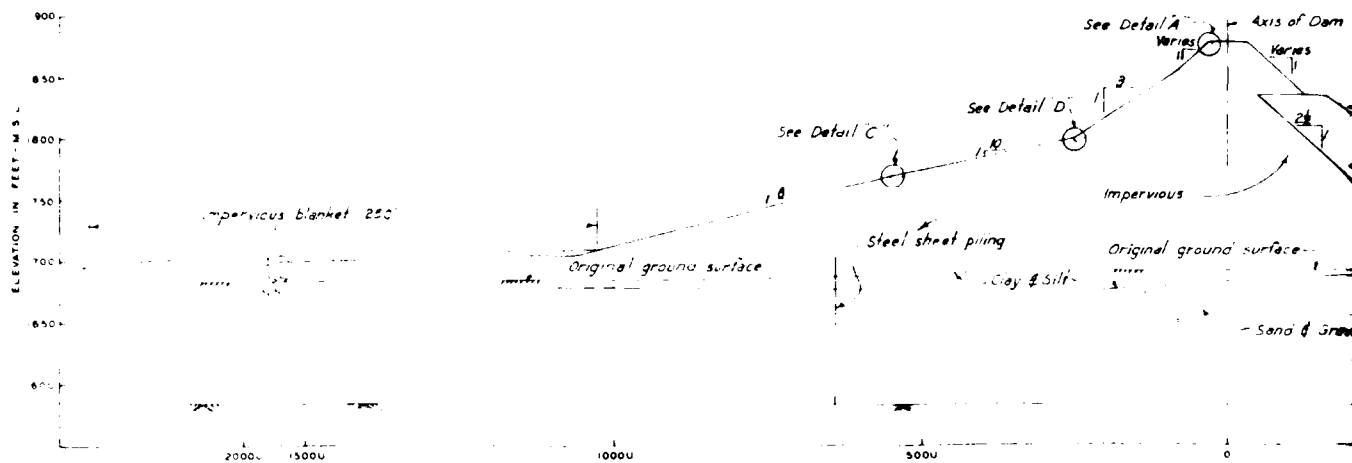
U.S. ARMY ENGINEER DISTRICT, OMAHA  
CORPS OF ENGINEERS  
OMAHA, NEBRASKA

GARRISON DAM-LAKE SAKAKAWEA  
DAM  
EMBANKMENT SECTIONS

CONSTRUCTION FOUNDATION REPORT

(1982)

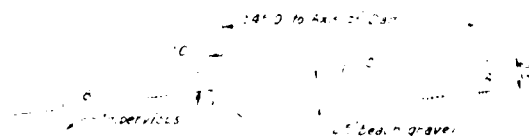
PLATE 82



**SECTION**  
STA. 88+00  
SCALE: HORIZ 1 IN = 100 FT  
VERT 1 IN = 50 FT



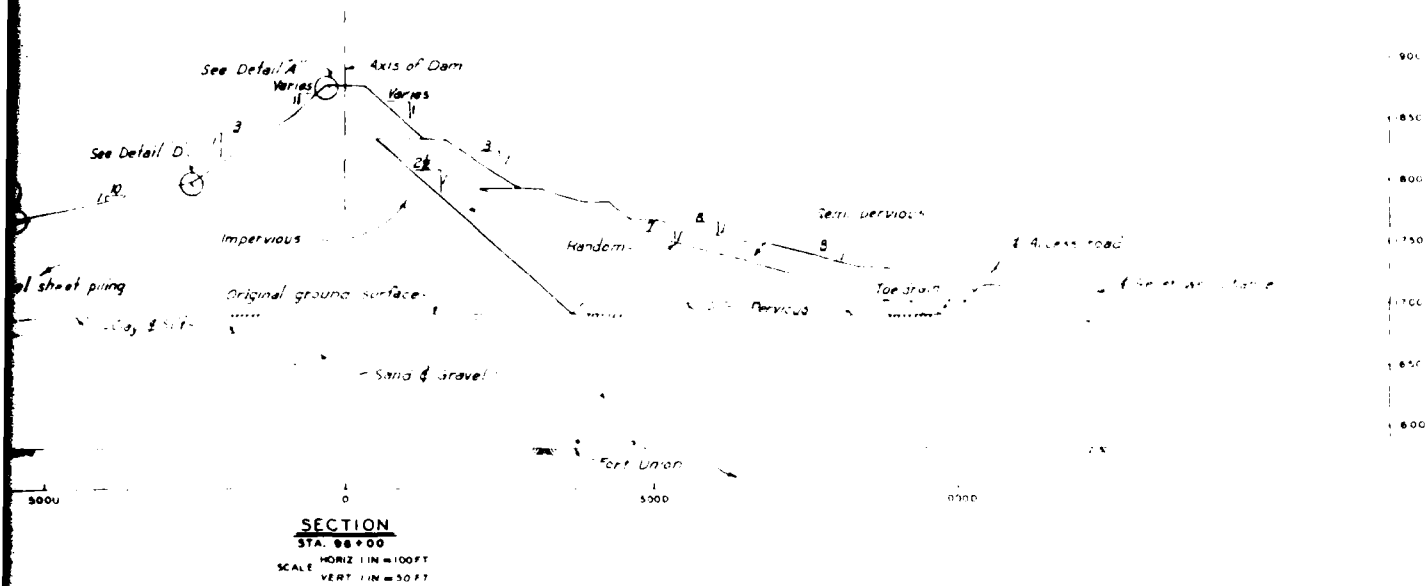
**DETAIL "A"**  
SCALE 1 IN = 5 FT



**DETAIL "C"**  
SCALE 1 IN = 5 FT



**DETAIL "D"**  
SCALE 1 IN = 5 FT



slope protection  
blanket

THIS DRAWING HAS BEEN PREPARED TO  
SHOW THE LOCATION OF THE DAM AND SLUICE



THIS PLAN ACCOMPANIES CONTRACT NO.  
DA-38-066-40 MODIFICATION NO.

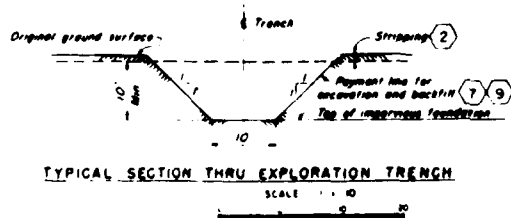
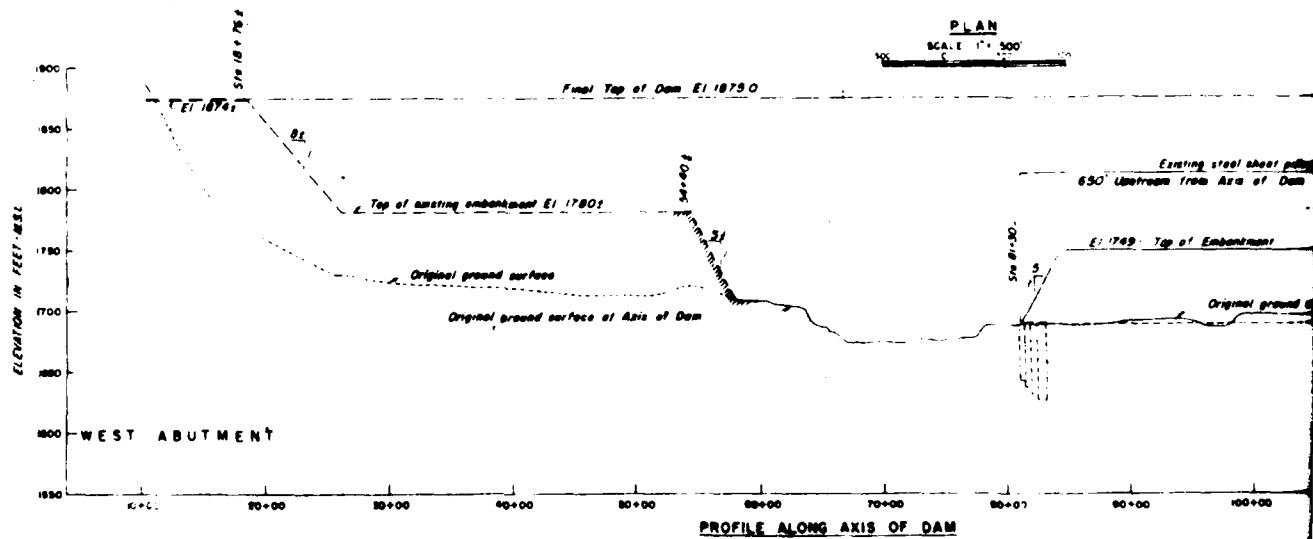
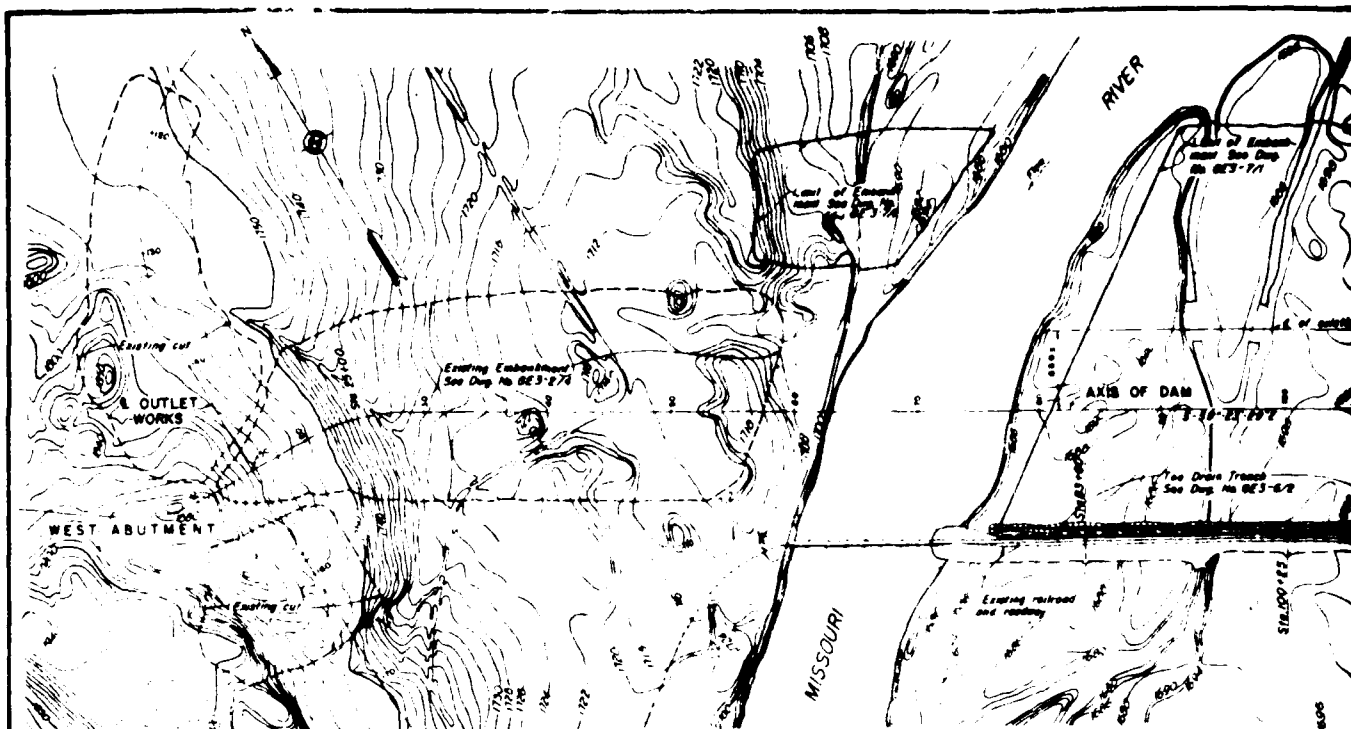
DATE	DESCRIPTION	MADE	APPROVED
	DESIGNED BY		
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
DESIGNED BY	MISSOURI RIVER		
FORWARDED BY	GARRISON DAM-LAKE SAKAKAWEA		
DESIGNED BY	DAM		
FORWARDED BY	EMBANKMENT SECTIONS		
DESIGNED BY	AND DETAILS		
FORWARDED BY	SCALE AS SHOWN		
DESIGNED BY	SHEET NO. 83 OF 84		
FORWARDED BY	DRAWING NUMBER		
DESIGNED BY	SHEET		

CONSTRUCTION FOUNDATION REPORT

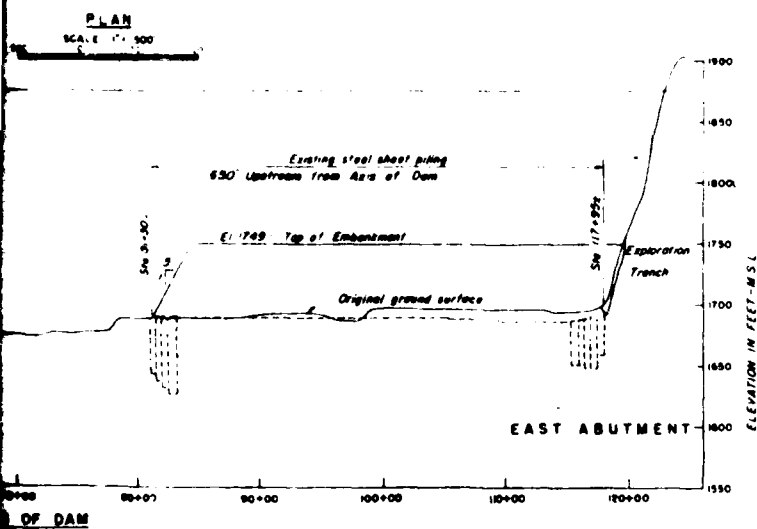
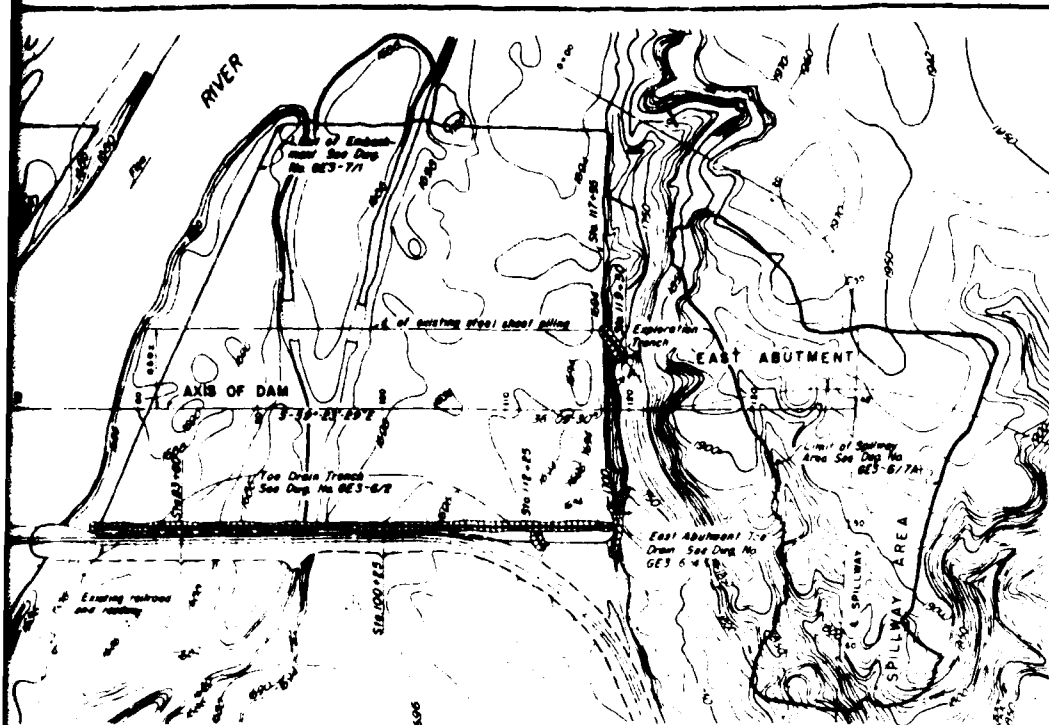
(1982)

PLATE 83

2







#### NOTES

Figures in hexagons indicate item numbers under which payment will be made.  
For geologic profile of Too Drain see Dig No. GE3-5/8.  
For geologic profile of exploration trench see Dig No. GE3-5/9.

REV.	DATE	REVISED BY	BY	APP.
DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.				
MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR FOUNDATION PREPARATION</b>				
PLAN, PROFILE AND SECTION				
SUBMITTED BY CHIEF, DESIGN BRANCH		APPROVED BY DISTRICT ENGINEER		
DATE AUGUST 1948		SCALE AS SHOWN		
DRAWN BY GE3-6/1		CHECKED BY GE3-6/1		

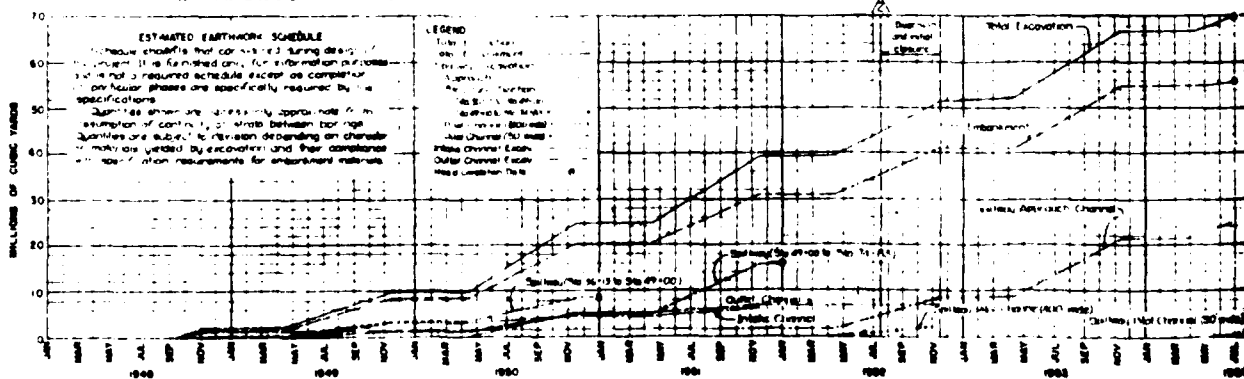
CONSTRUCTION FOUNDATION REPORT

(1982)

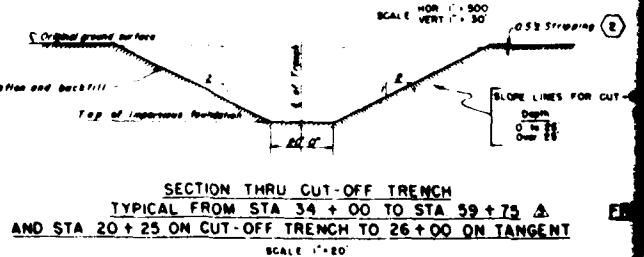
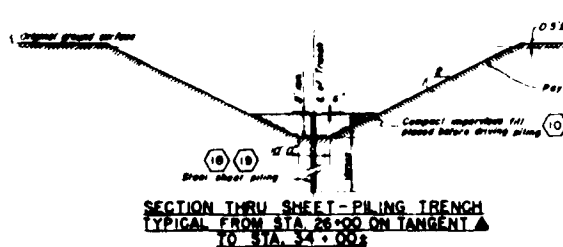
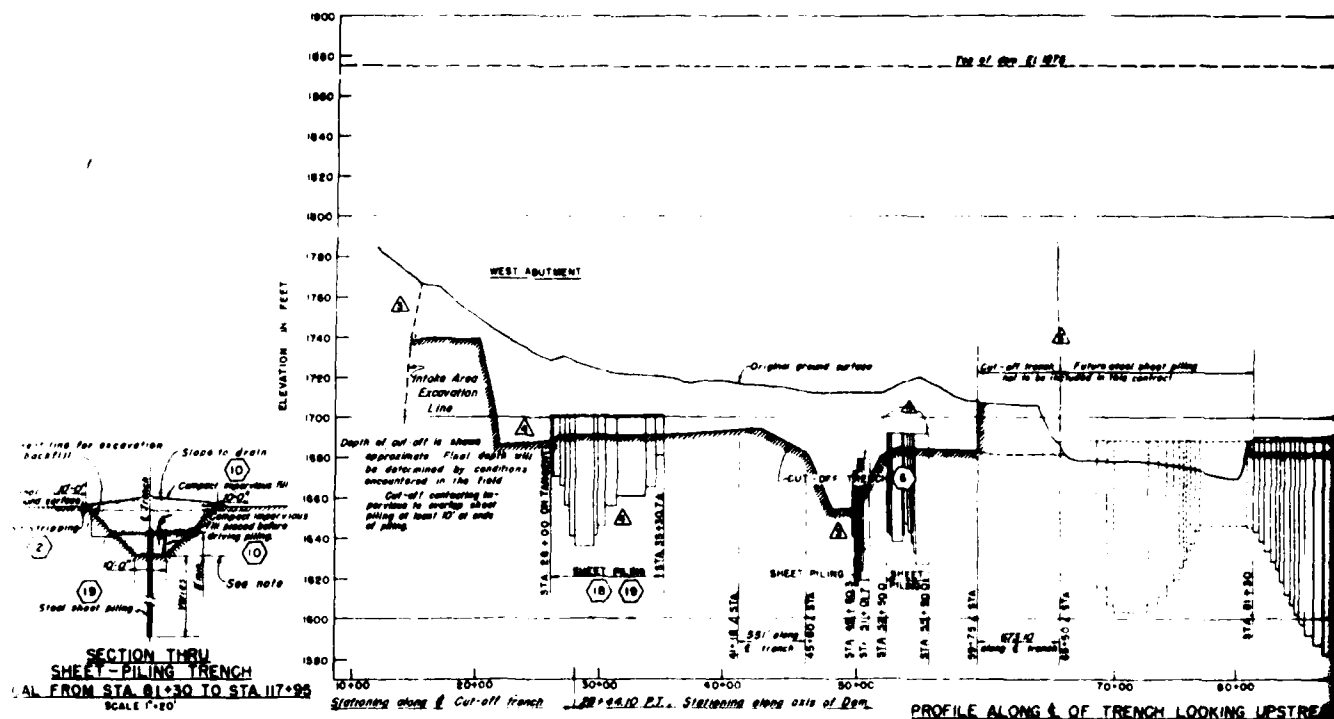
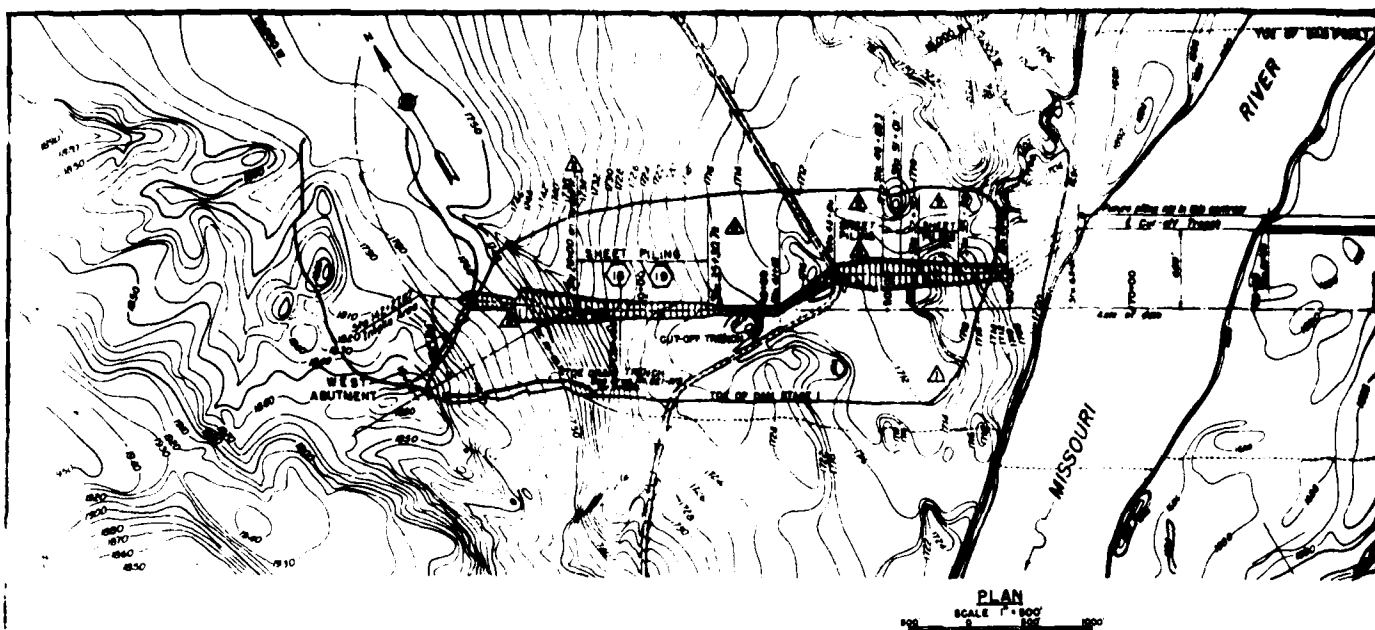
PLATE 84

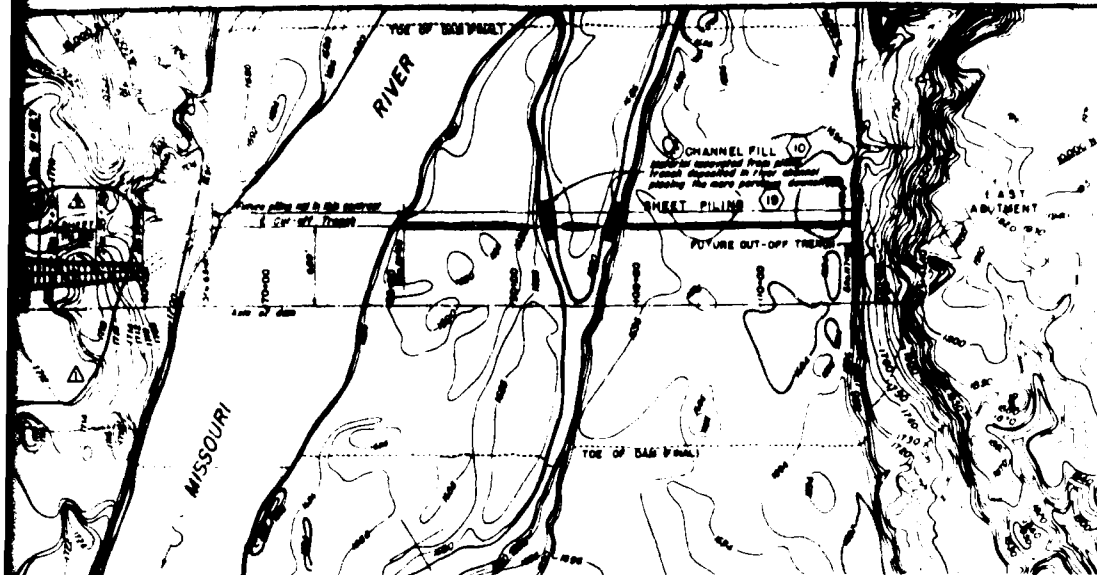
NOTE: QUANTITIES ARE IN THOUSANDS OF CU YDS.

SOURCE	EXCAVATION YIELD TOTAL CU YDS	1948-49				1950				1951				1952				1953			
		EXCAV EMB	WASTE EMB	WASTE EMB	WASTE EMB	EXCAV EMB	WASTE EMB	WASTE EMB	WASTE EMB	EXCAV EMB	WASTE EMB	WASTE EMB	WASTE EMB	EXCAV EMB	WASTE EMB	WASTE EMB	WASTE EMB				
<b>SPILLWAY APPROACH</b>																					
Sta 3+00 to Sta 3+43	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>STRUCTURE SECTION</b>																					
Sta 3+43 to Sta 4+00	70.1	32.7	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	70.1	32.7	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	70.1	32.7	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	70.1	32.7	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>INTAKE CHANNEL</b>																					
Sta 4+00 to Sta 4+20	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>OUTLET CHANNEL</b>																					
Sta 4+20 to Sta 4+40	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>TOE TRENCHES</b>																					
Sta 4+40 to Sta 4+60	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>COLLECTOR DITCH</b>																					
Sta 4+60 to Sta 4+80	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>EMBANKMENT AREA</b>																					
Sta 4+80 to Sta 5+00	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
<b>BORROW AREAS</b>																					
Sta 5+00 to Sta 5+20	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											
General Excavation	130.35	70.1	32.7	32.7	32.7	1.20	30	4.57	40.7	36.8											

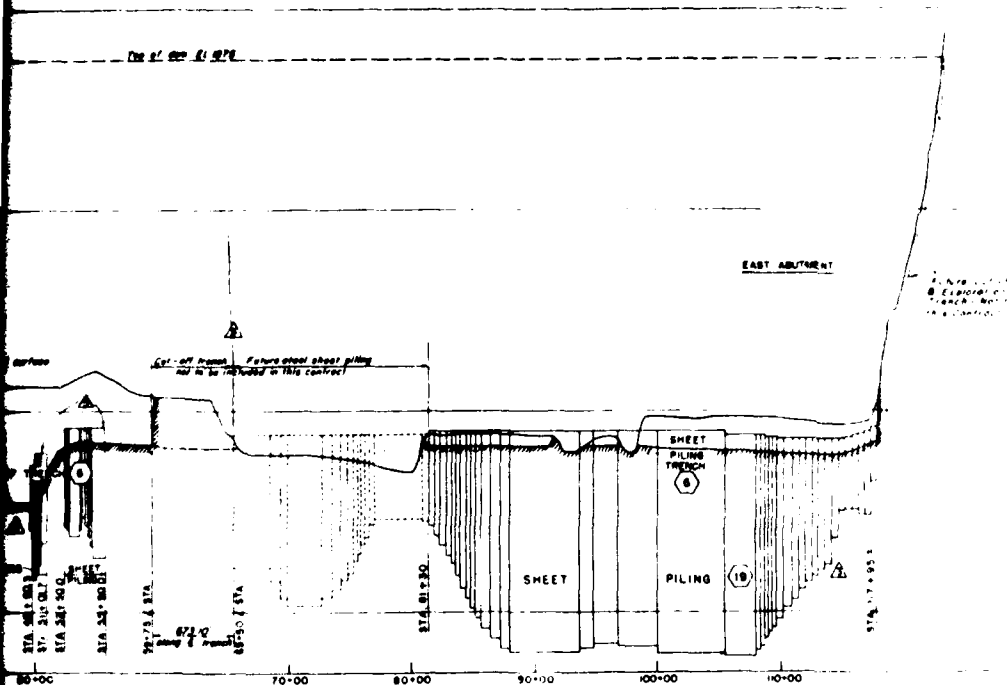






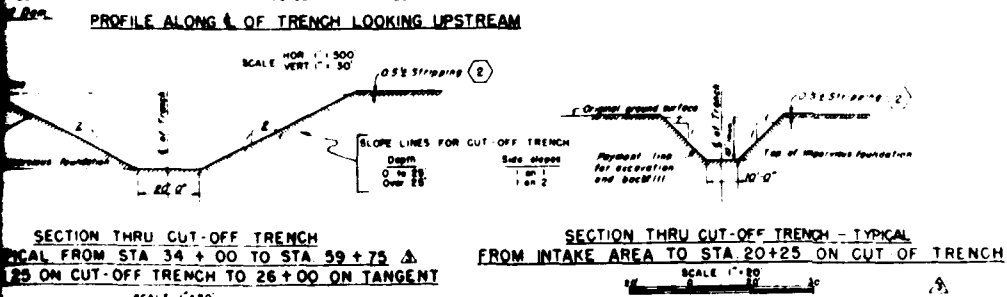


STATION TO STATION	TOP ELEVATION	LENGTH OF PILING	NO. OF PIECES
8+30	1591	12	10
8+40	1591	12	10
8+50	1591	12	10
8+60	1591	12	10
8+70	1591	12	10
8+80	1591	12	10
8+90	1591	12	10
9+00	1591	12	10
9+10	1591	12	10
9+20	1591	12	10
9+30	1591	12	10
9+40	1591	12	10
9+50	1591	12	10
9+60	1591	12	10
9+70	1591	12	10
9+80	1591	12	10
9+90	1591	12	10
10+00	1591	12	10
10+10	1591	12	10
10+20	1591	12	10
10+30	1591	12	10
10+40	1591	12	10
10+50	1591	12	10
10+60	1591	12	10
10+70	1591	12	10
10+80	1591	12	10
10+90	1591	12	10
11+00	1591	12	10
11+10	1591	12	10
11+20	1591	12	10
11+30	1591	12	10
11+40	1591	12	10
11+50	1591	12	10
11+60	1591	12	10
11+70	1591	12	10
11+80	1591	12	10
11+90	1591	12	10
12+00	1591	12	10

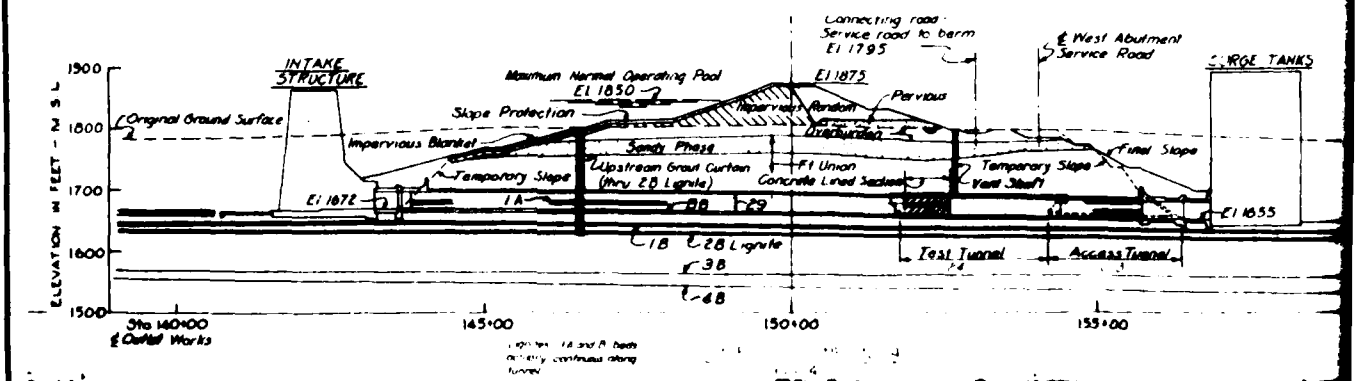
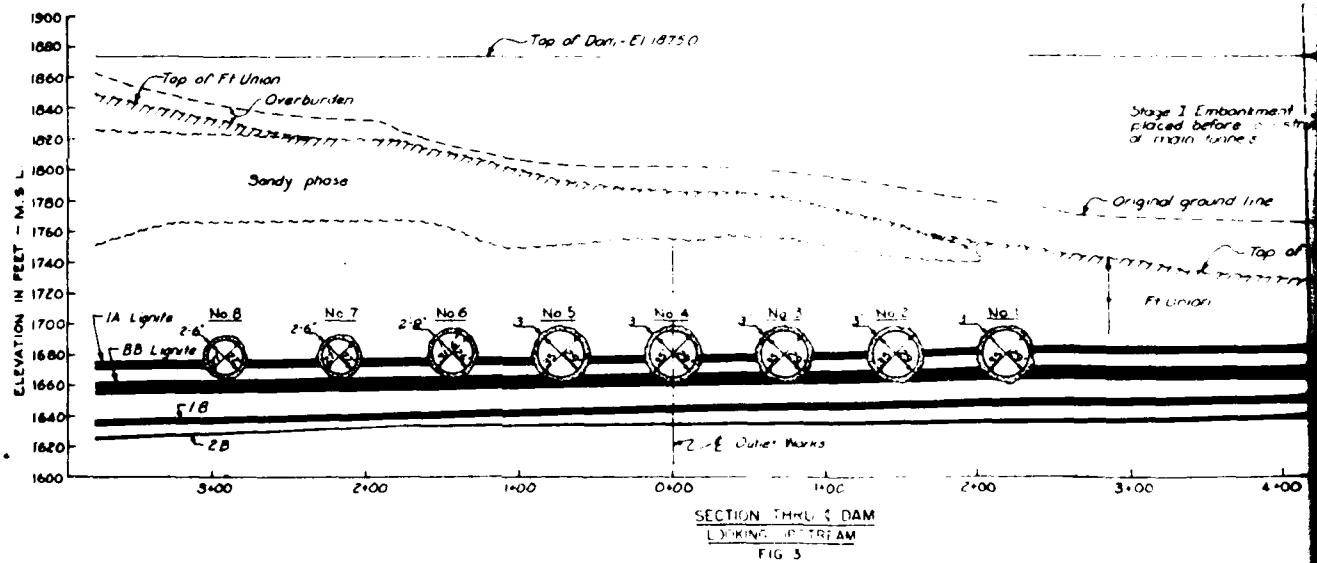
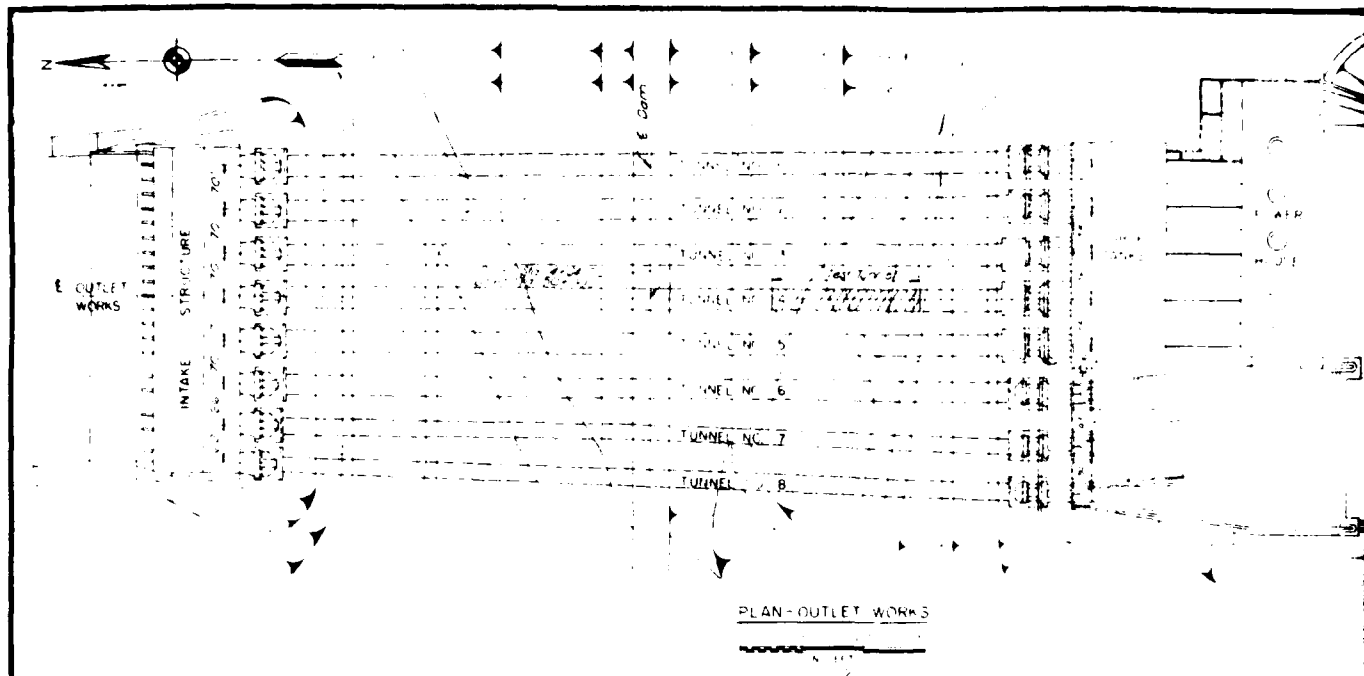


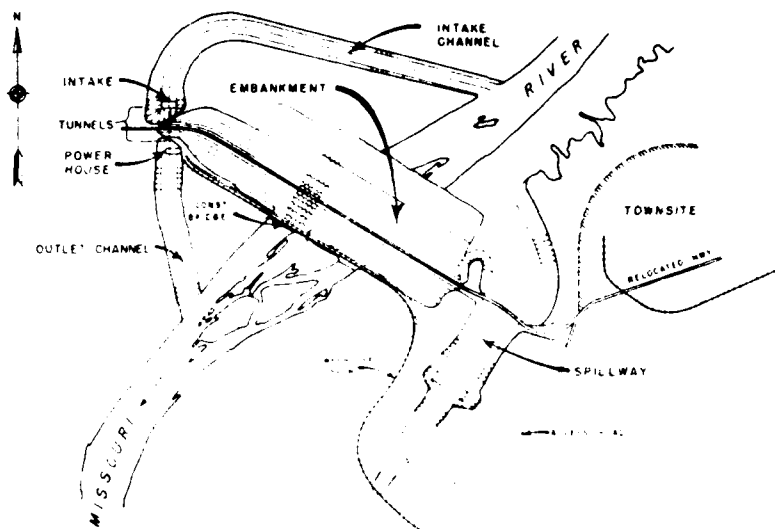
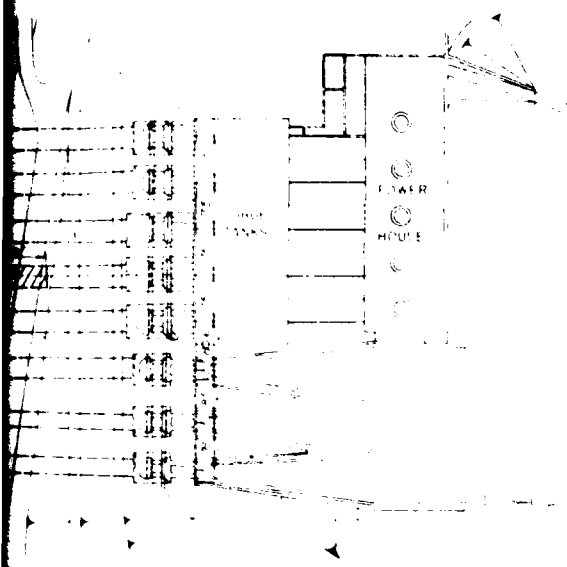
STATION TO STATION	TOP ELEVATION	LENGTH OF PILING	NO. OF PIECES
12+10	1591	12	10
12+20	1591	12	10
12+30	1591	12	10
12+40	1591	12	10
12+50	1591	12	10
12+60	1591	12	10
12+70	1591	12	10
12+80	1591	12	10
12+90	1591	12	10
13+00	1591	12	10
13+10	1591	12	10
13+20	1591	12	10
13+30	1591	12	10
13+40	1591	12	10
13+50	1591	12	10
13+60	1591	12	10
13+70	1591	12	10
13+80	1591	12	10
13+90	1591	12	10
14+00	1591	12	10

1. Elevations refer to Mean Sea Level Datum.
2. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
3. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
4. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
5. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
6. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
7. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
8. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
9. Piling shall be driven to a depth of 10 feet below the bottom of the trench.
10. Piling shall be driven to a depth of 10 feet below the bottom of the trench.

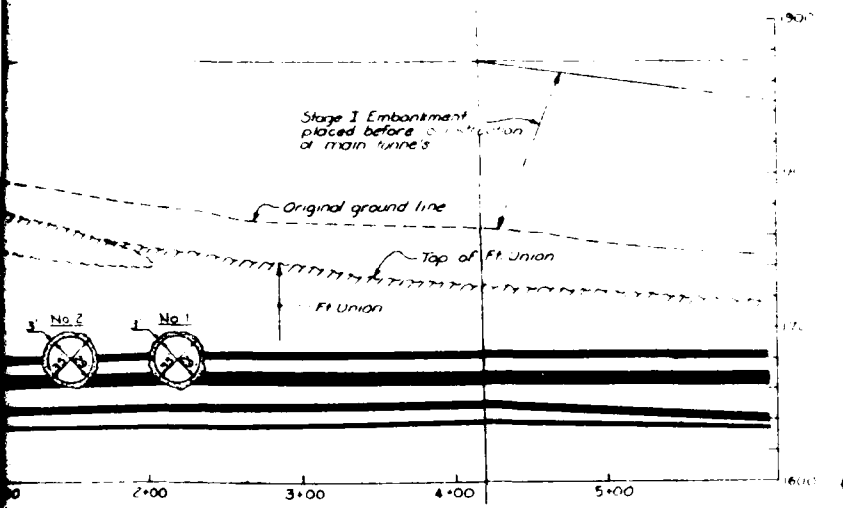


GARRISON DAM AND RESERVOIR	
FOUNDATION PREPARATION	
DATE	1947
BY	GEI-6/1

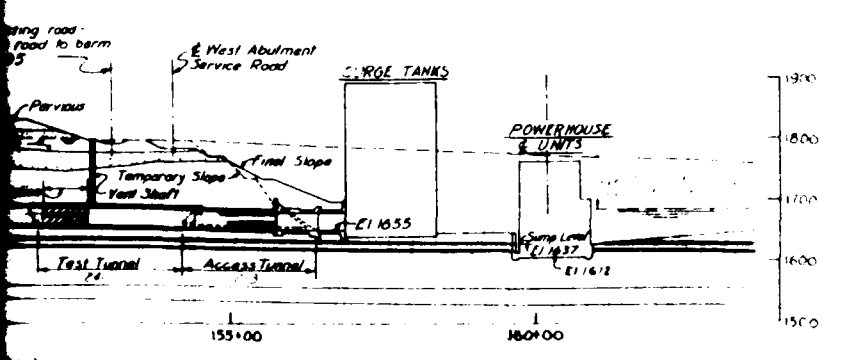




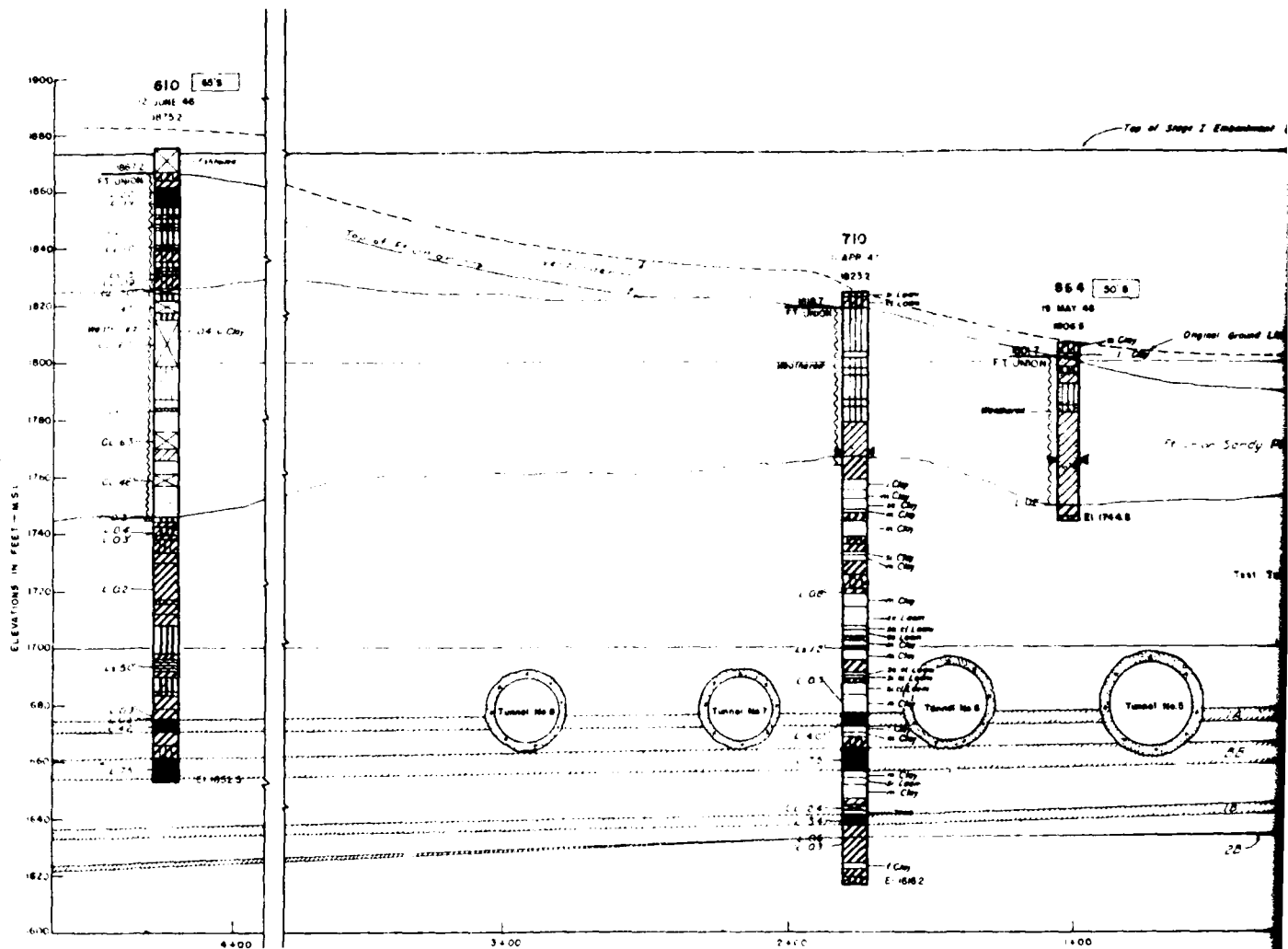
WORKS



DAM  
AM



CORPS OF ENGINEERS, U. S. ARMY	
OFFICE OF THE DISTRICT ENGINEER	
COLUMBIA RIVER DISTRICT	
MISSOURI RIVER	
GARRISON DAM AND RESERVOIR	
TUNNELS	
MARCH 1953	



#### GRAIN SIZE SYMBOLS

	Sand		Silt
	Gravel		Clay

#### OTHER SYMBOLS

	Limestone (L.S.)		Core Lost (C.L.)
	Lignite (L.)		Fishtailed (Wash boring not sampled)

Symbols represent grain size distribution, predominant types by heavy lines, modifying types by light lines.

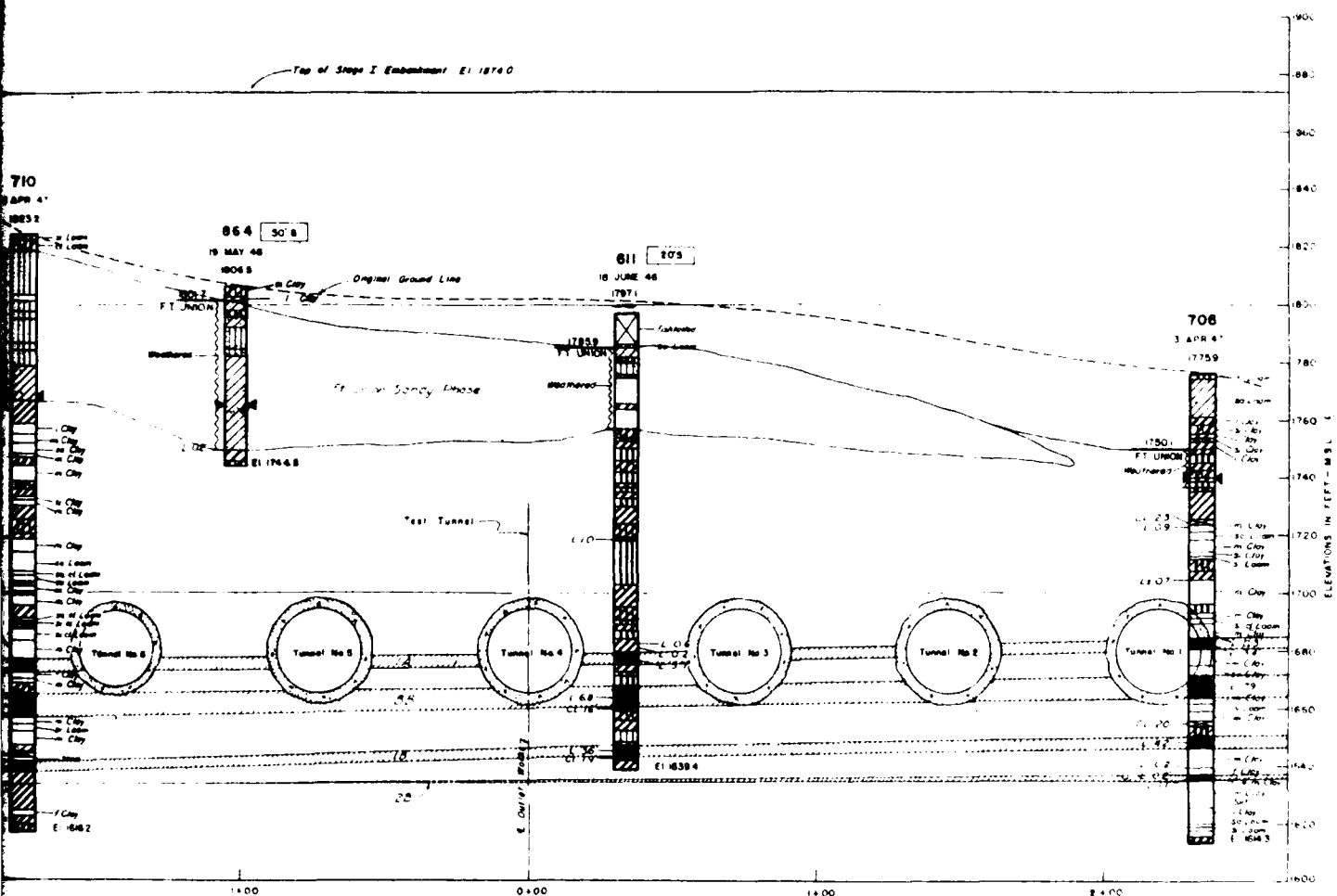
#### ABBREVIATIONS USED

grav - gravelly	l - lean (clay)
ss - sandy	m - medium (clay)
sl - silty	f - fat (clay)
cl - clayey	

Lean medium & fat clays are not differentiated in Ft. Union.  
Fine medium & coarse sands are not differentiated.

SECTION THRU E. D.  
LOOKING UPSTREAM  
SCALE 1"=20'





# SECTION THRU & DAM LOOKING UPSTREAM SCALE 1"=20'

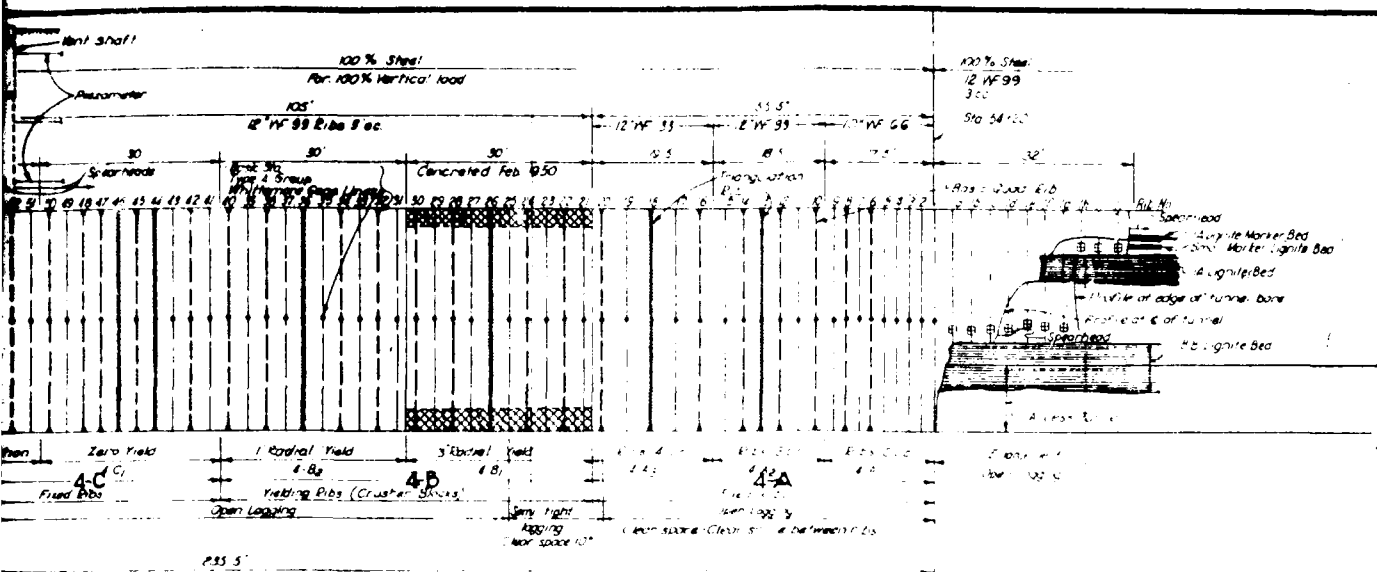
## ABBREVIATIONS USED

Gravelly Clay  
Sandy Clay  
Silty Clay  
Fat Clay  
Lean Clay  
Medium Clay  
Fat Clay  
Sandy Clay  
Silty Clay  
Fat Clay

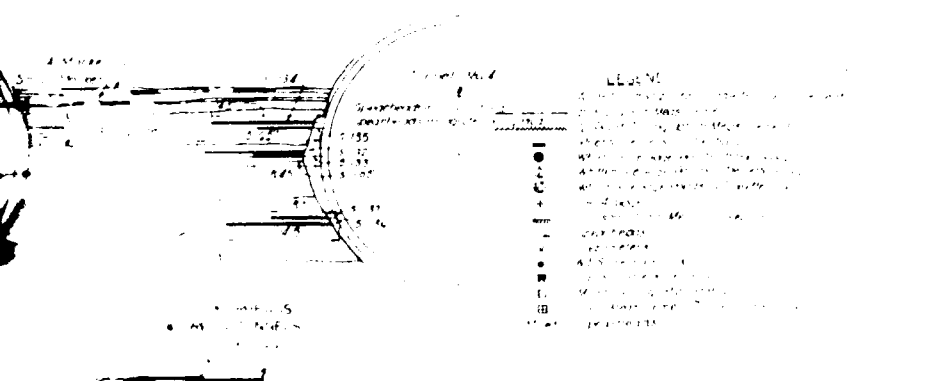
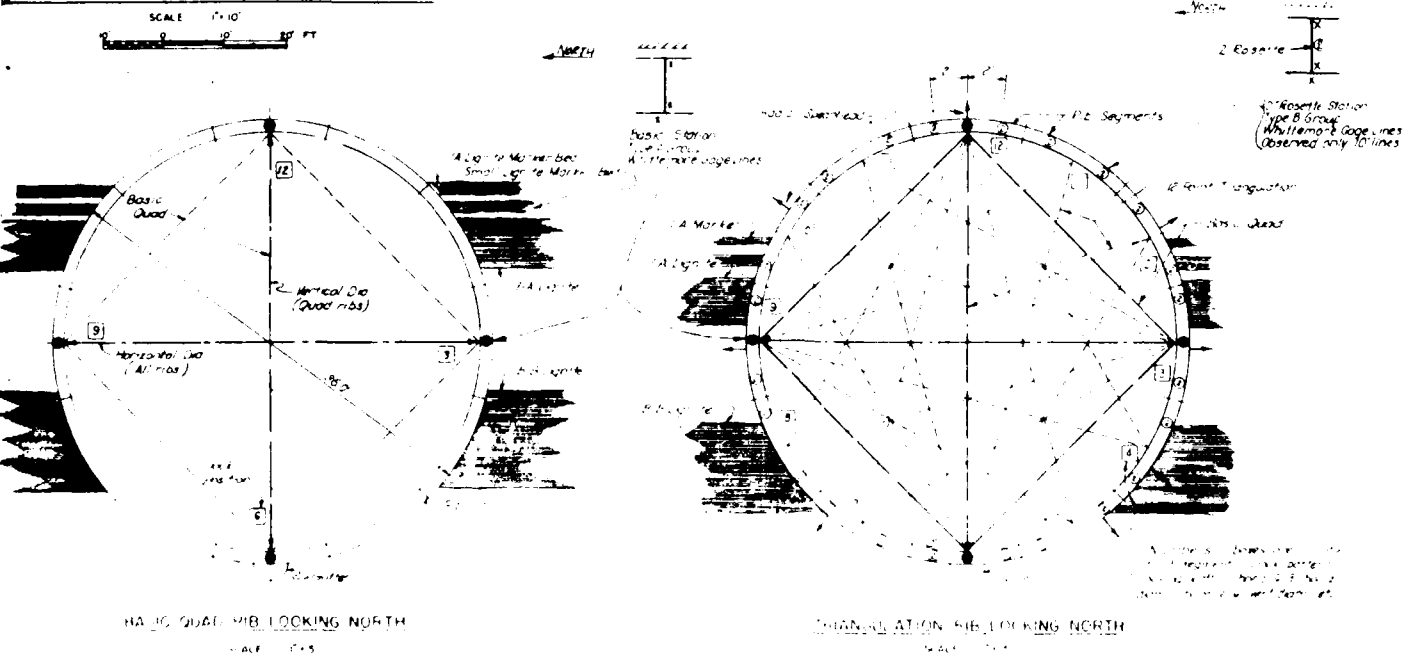
Lean & fat clays are not differentiated  
Sandy & silty clays are not differentiated

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR GEOLOGIC SECTION THROUGH TUNNELS	
DATE AUGUST 1949	BY J. B. L. L. L.
NO. 602-5/7	





MEASURING ARRANGEMENT THRU TEST TUNNEL



U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MISSOURI RIVER	
GARRISON DAM AND RESERVOIR	
TEST TUNNEL	
GENERAL INSTRUMENTATION LAYOUT	
DATE: MARCH 1953	BY: [Signature]
SCALE: 1\"/>	

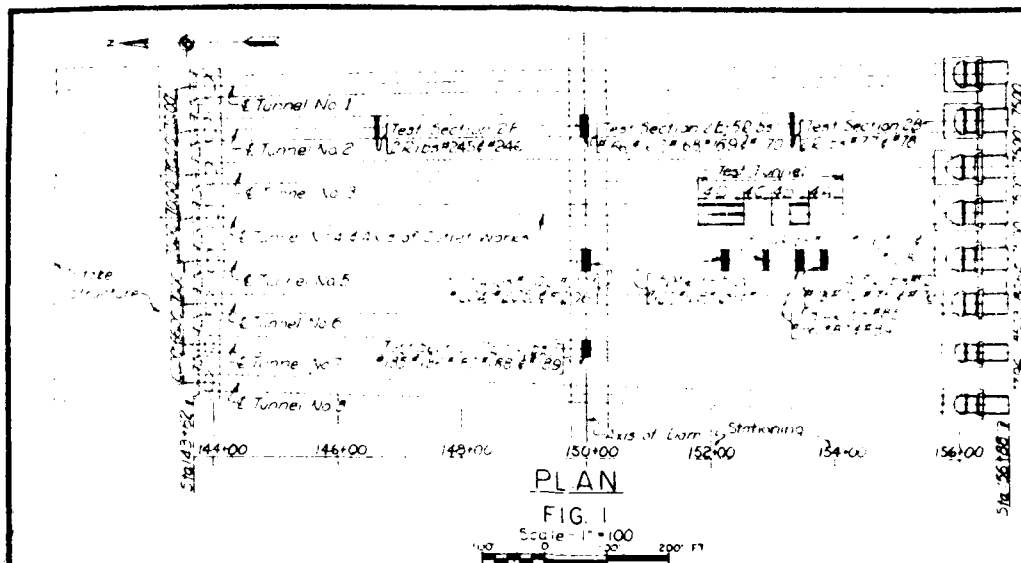
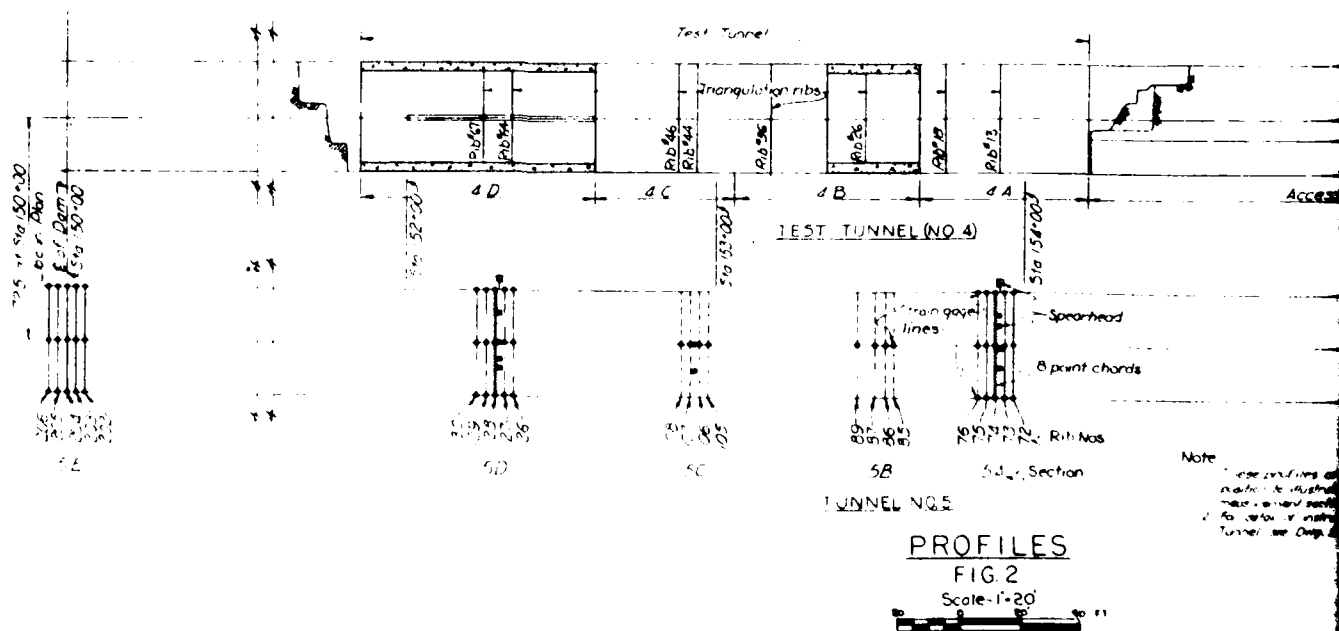
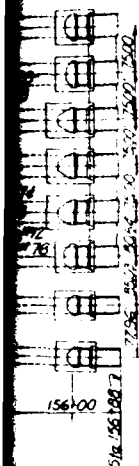


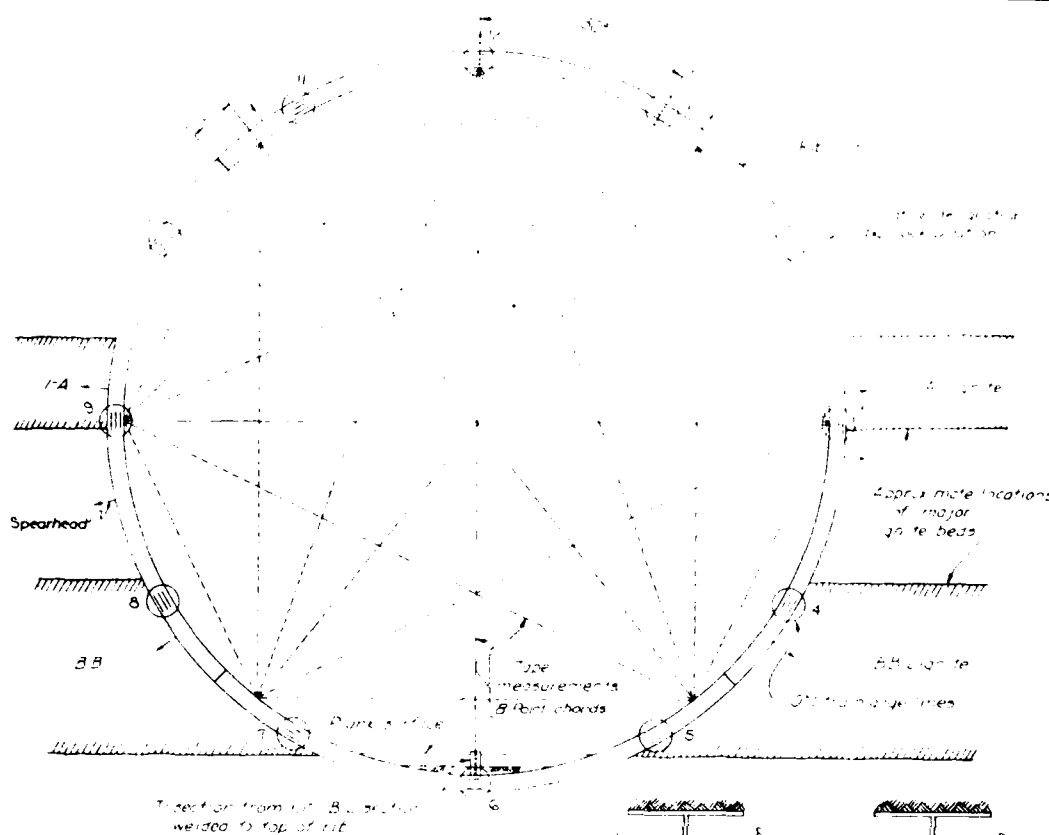
		Table of observation points																																					
Tunnel		2								5																7													
Section		2B		2E		2F		5A				5B		5C				5D				5E				7E													
Point		77	78	65	67	68	69	70	24	24	72	73	74	75	76	85	86	87	89	92	95	96	97	100	126	127	128	129	130	202	203	204	205	206	405	406	407	408	409
Type Measurements	Hor	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Vert	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	Beam																																						
Strain Gage Observations	Hor	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	Vert	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
	Beam																																						
	12pts																											X											
Spearheads																					*	*							*	*									
Rib size		8WF40		10WF72		8WF40		10WF72				10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF72		10WF49			
Rib Spacing		4' oc		3.5' oc		4' oc		3' oc				3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		3' oc		4' oc			

FIG. 4

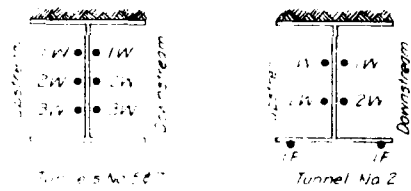




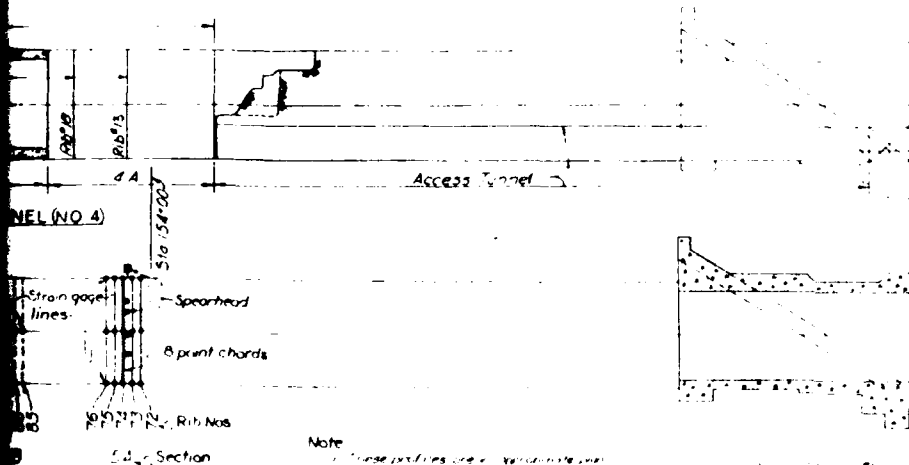
7									
5E					7E				
20	20	20	20	20	20	20	20	20	20
X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X
10W 72					10W 49				
3' oc					4' oc				



INSTRUMENTATION DETAIL  
FIG. 3



TYPICAL LOCATIONS  
OF STRAIN GAGE LINES  
FIG. 5



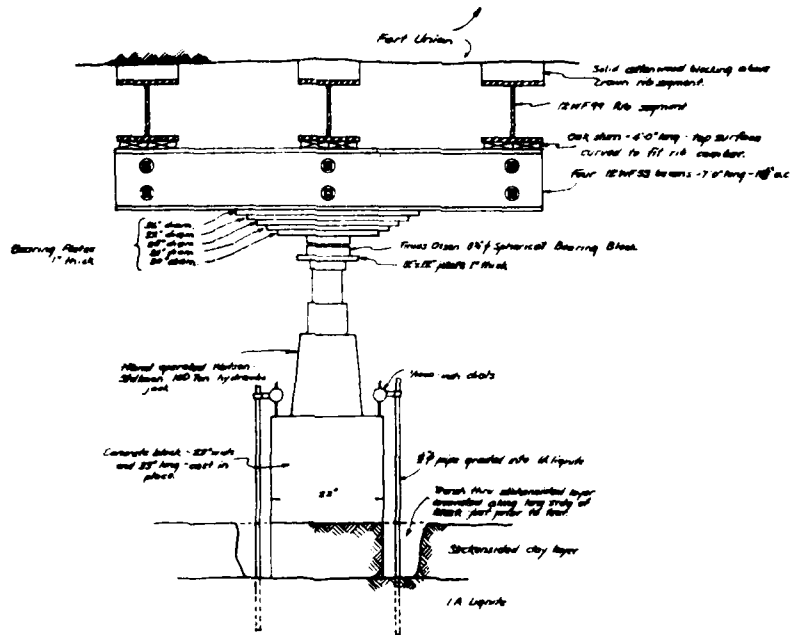
Note:  
1. These profiles are in accordance with  
plans for structure, which show  
max. inward settlement  
2. For details of instrumentation see Test  
Tunnel and Dam No. 100

Legend:  
— Rib Nos.  
— 8 Point Chords  
• Strain gage lines  
— Spearheads

PROFILES  
FIG. 2  
Scale-1"=20'

U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER STATIONED AT ST. LOUIS	
MISSOURI RIVER GARRISON DAM AND RESERVOIR TUNNELS MEASUREMENTS, PLANS AND DETAILS	
ASSEMBLED BY <i>[Signature]</i>	DATE MARCH 1953
APPROVED BY <i>[Signature]</i>	PROJECT NO. FT-210

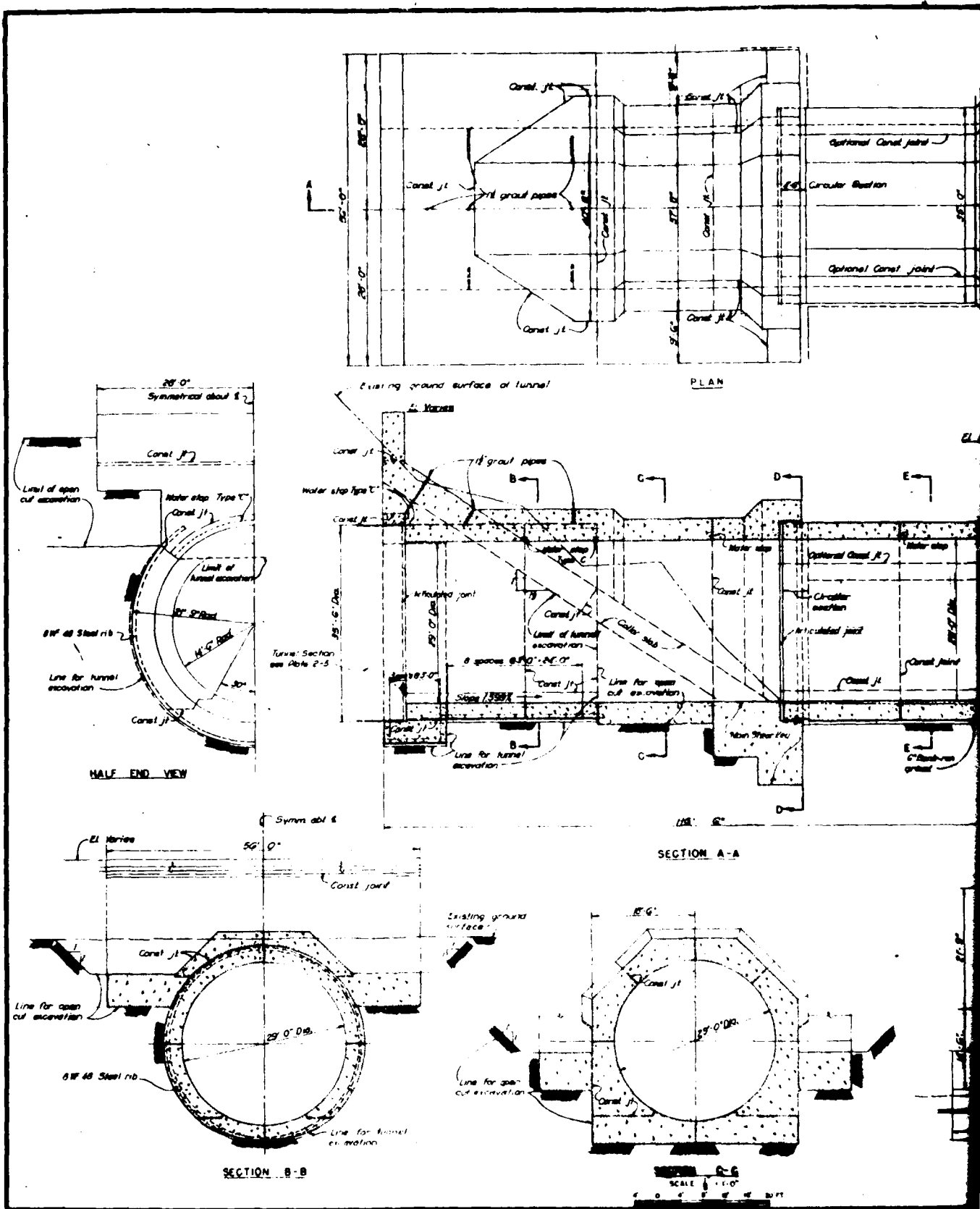




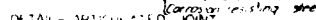
SQUEEZE TEST ARRANGEMENT

Scale - 1" = 1'-0"

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR TEST TUNNEL SQUEEZE TESTS LOCATION AND ARRANGEMENT	
DATE MAY 1940	BY FT-79



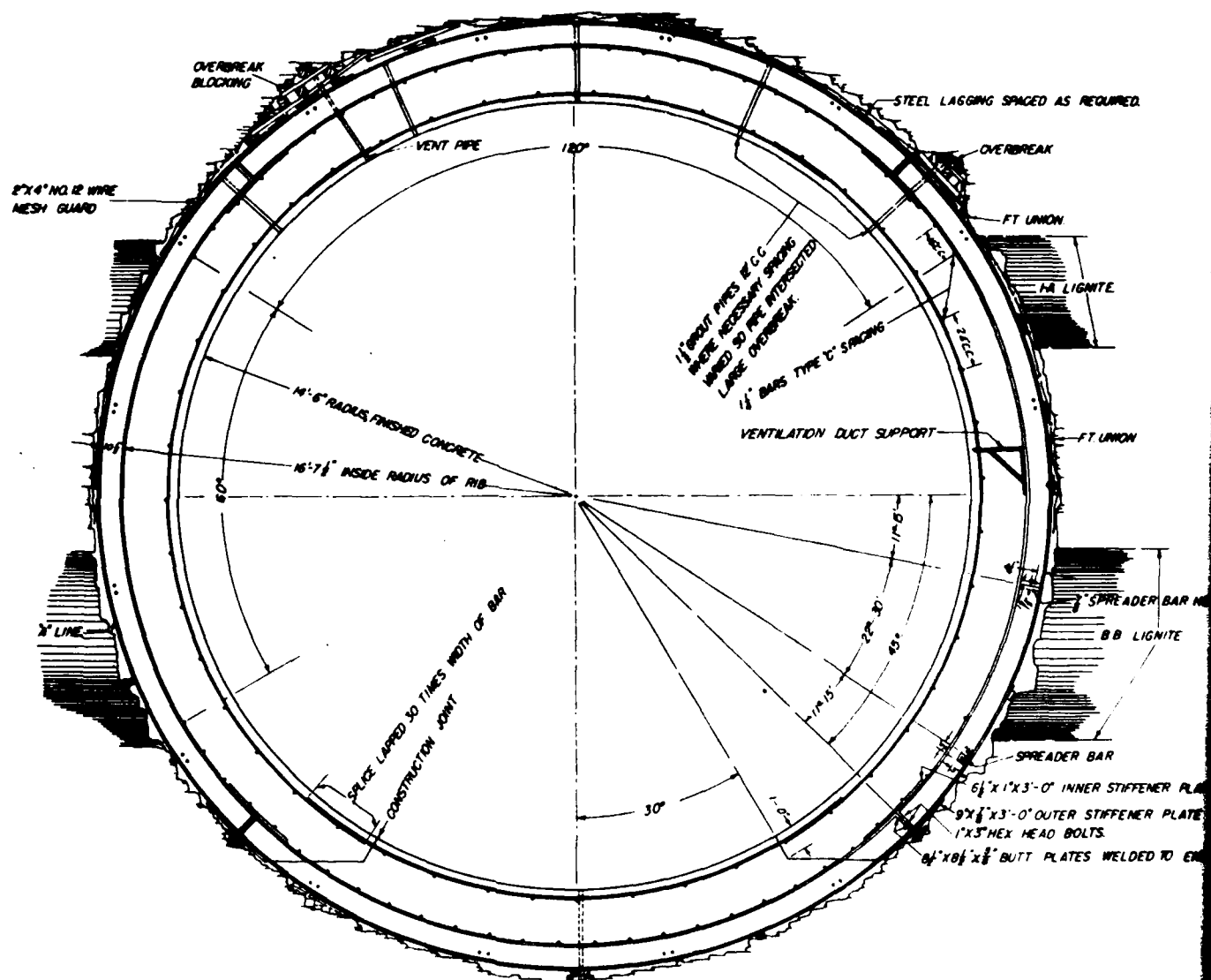


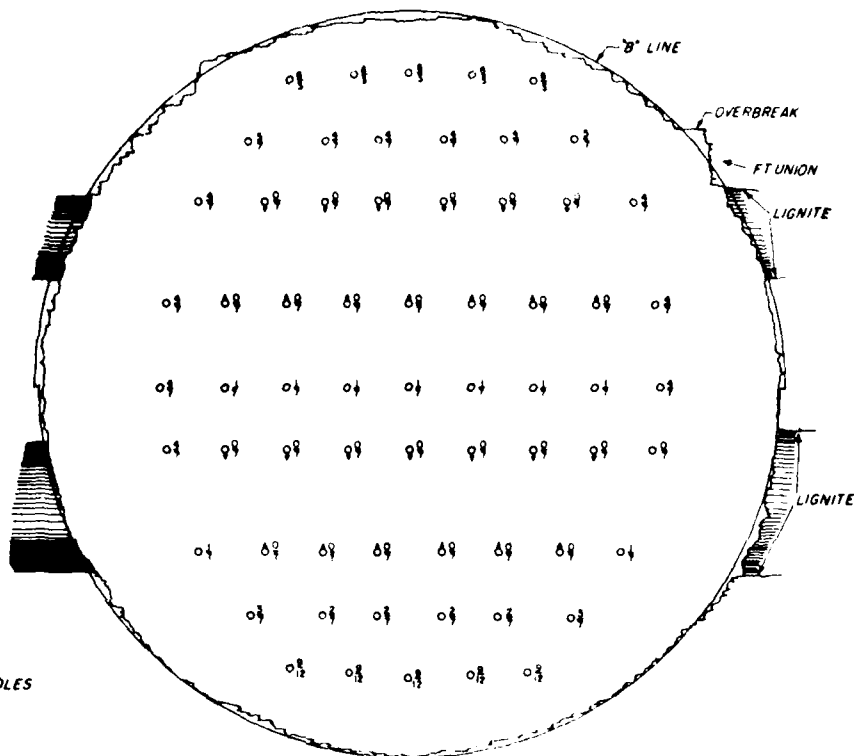
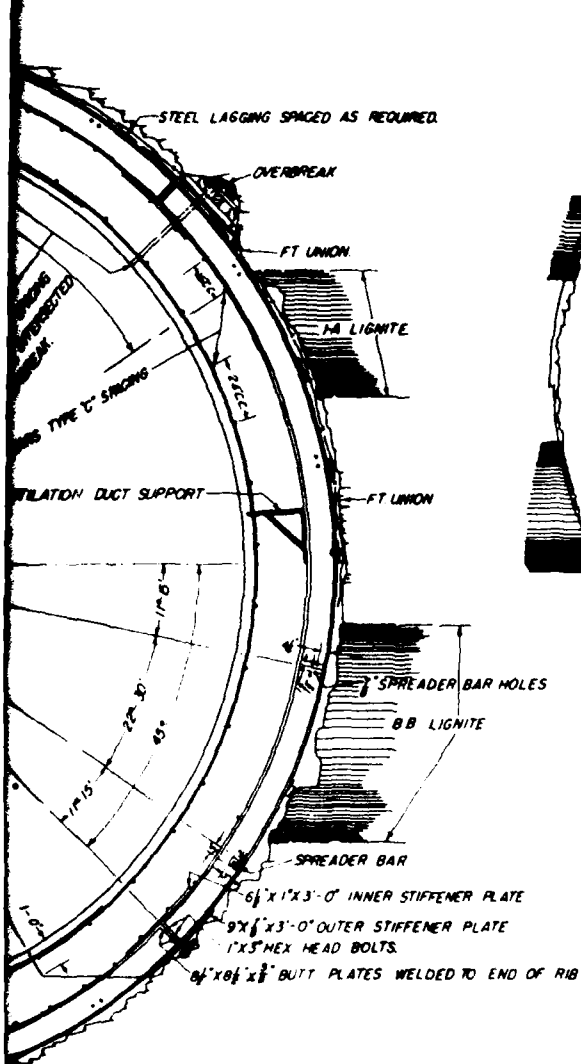


U. S. ARMY  
CORPS OF ENGINEERS  
OFFICE OF THE DISTRICT ENGINEER  
CHICAGO 15  
MISSOURI RIVER  
GARRISON DAM AND RESERVOIR  
29 FT TUNNELS  
TYPICAL DOWNSTREAM PORTALS

**MARCH 1953**

ET: 206

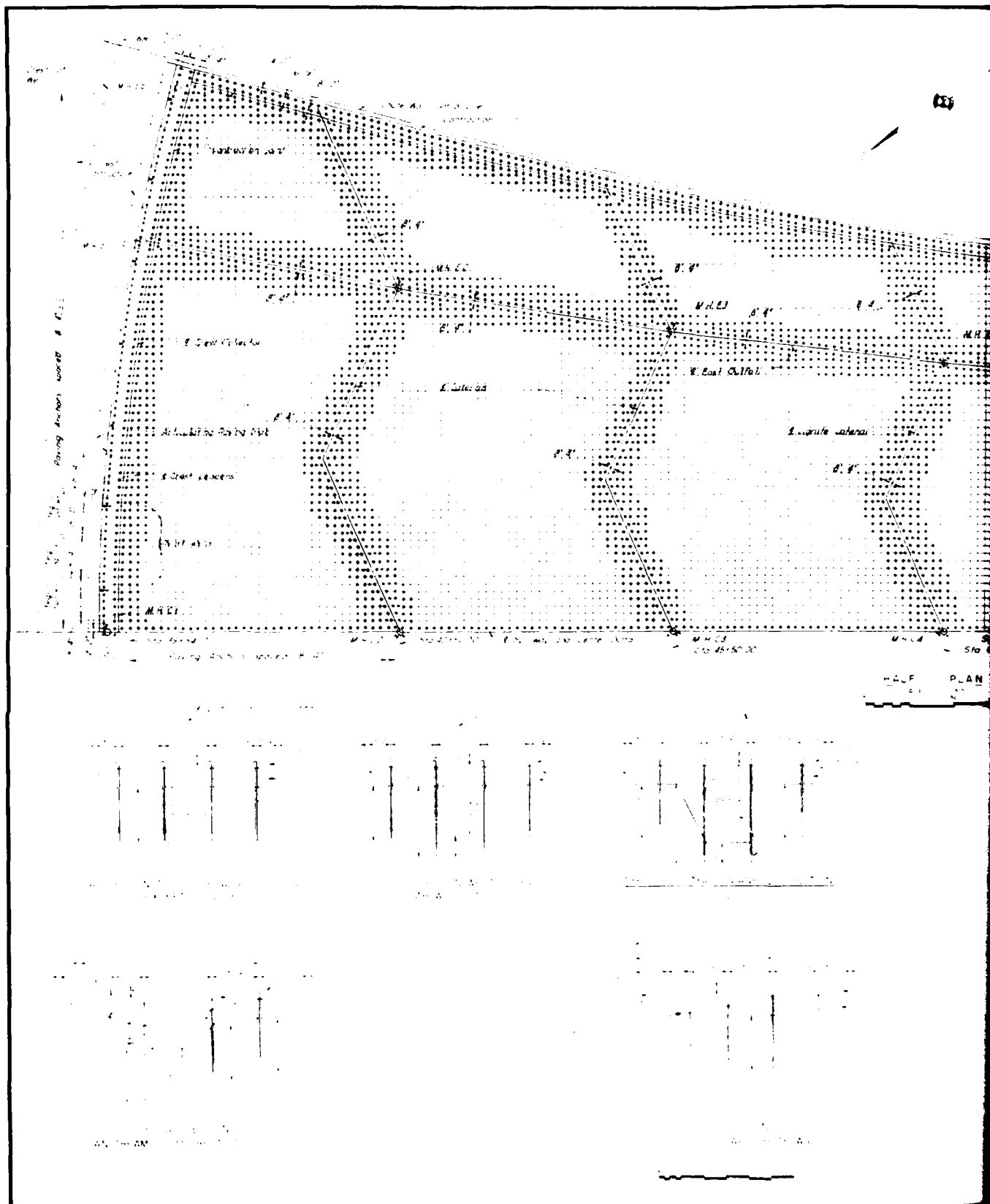


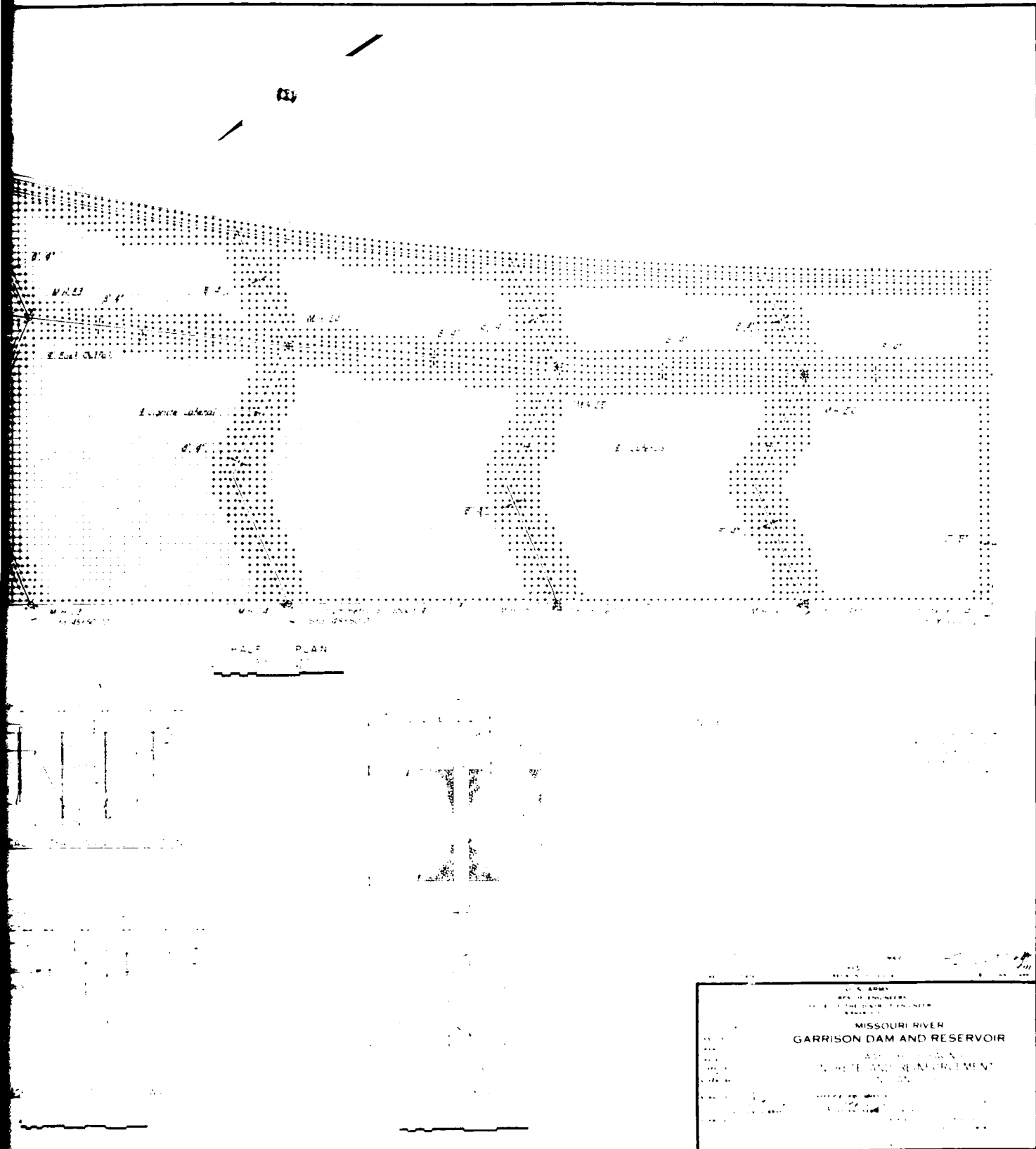


TYPICAL OVERBREAK AND BLASTING DIAGRAM

O HORIZONTAL HOLES  
 X DIRECTION OF HOLES  
 3' DELAY  
 7' NO OF STICKS  
 63 TO 90 HOLES  
 300 STICKS MONOBEL DYNAMITE  
 HEADING ADVANCE 8 FT PER ROUND

REV	DATE	REVISION	INITIALS
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.			
MISSOURI RIVER GARRISON DAM AND RESERVOIR 29 FT TUNNELS CONSTRUCTION CROSS SECTIONS			
DESIGNED BY DRAWN BY CHECKED BY APPROVED BY		MARCH 1953 FT-200	

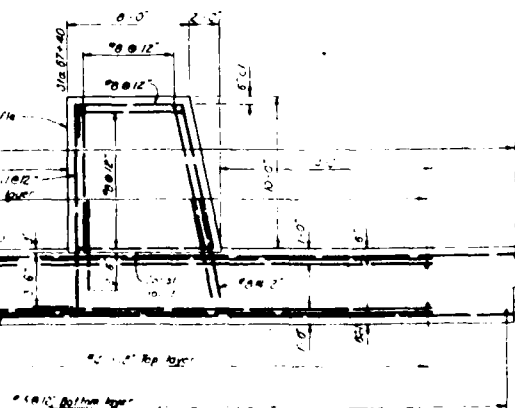
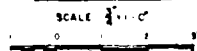
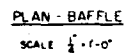
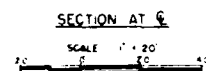




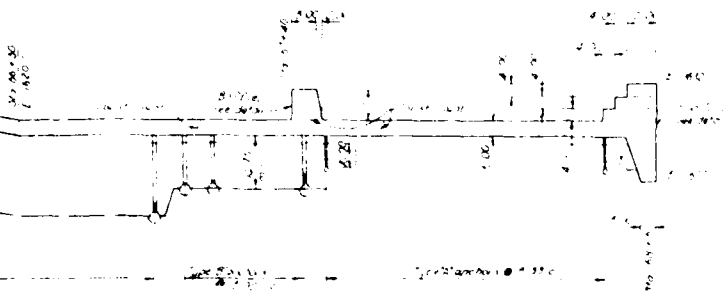
CONSTRUCTION FOUNDATION REPORT

(1982)

PLATE 94

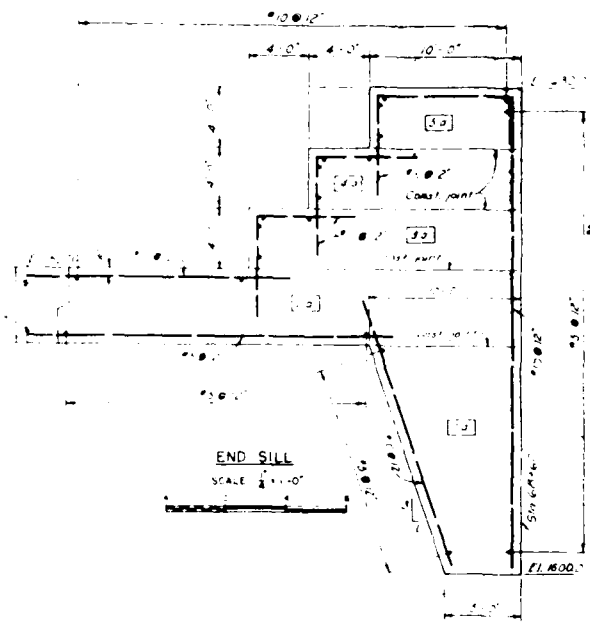


SECTION 1-E  
SCALE 1" = 1'-0"



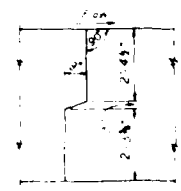
SECTION AT C

SCALE 1" = 20'



END SILL

SCALE 1" = 10'



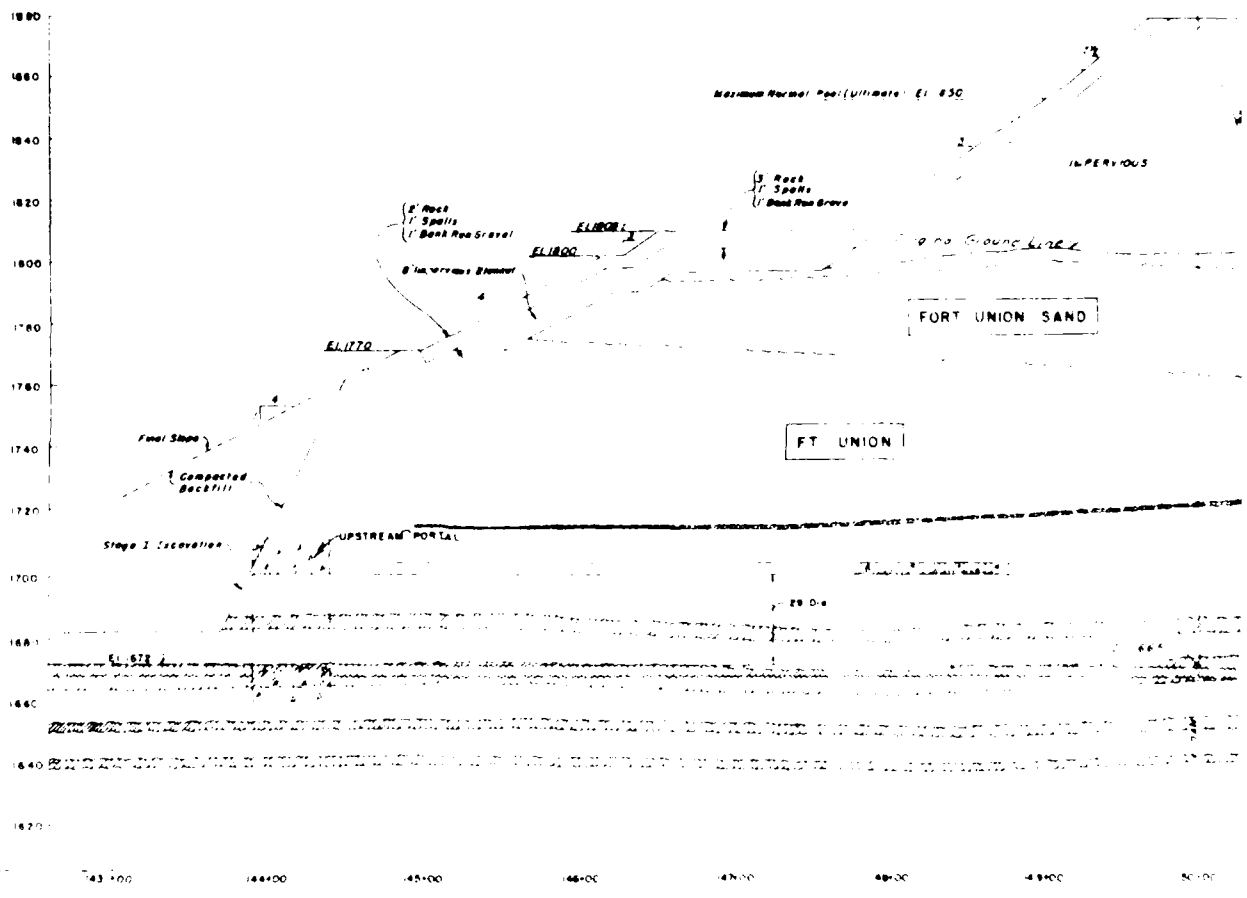
TRANSVERSE CONST JOINT  
INCLINED SLAB

SCALE 1" = 10'

NOTES

For bars or other details 30 bar diameter unless otherwise noted

U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER STATION 100	
MISSOURI RIVER GARRISON DAM AND RESERVOIR CHUTE AND STILLING BASIN SLAB CONCRETE AND REINFORCEMENT SLAB AND ANCHOR DETAILS STA 61+50 TO 61+60	
DESIGNED BY <i>[Signature]</i>	CHECKED BY <i>[Signature]</i>
AUGUST 1954	



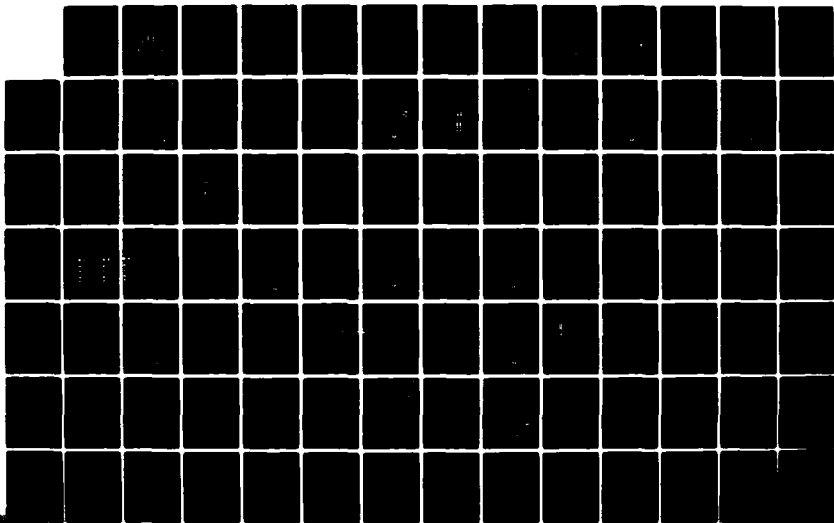


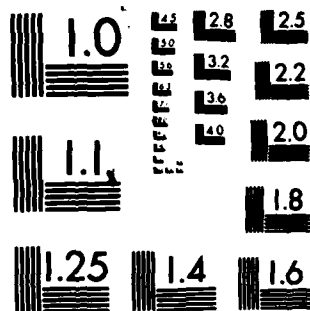
CONSTRUCTION FOUNDATION REPORT MISSOURI RIVER GARRISON  
DAM LAKE SAKAKAWEA VOLUME 2 DRAWINGS(U) ARMY ENGINEER  
DISTRICT OMAHA NE NOV 83

34

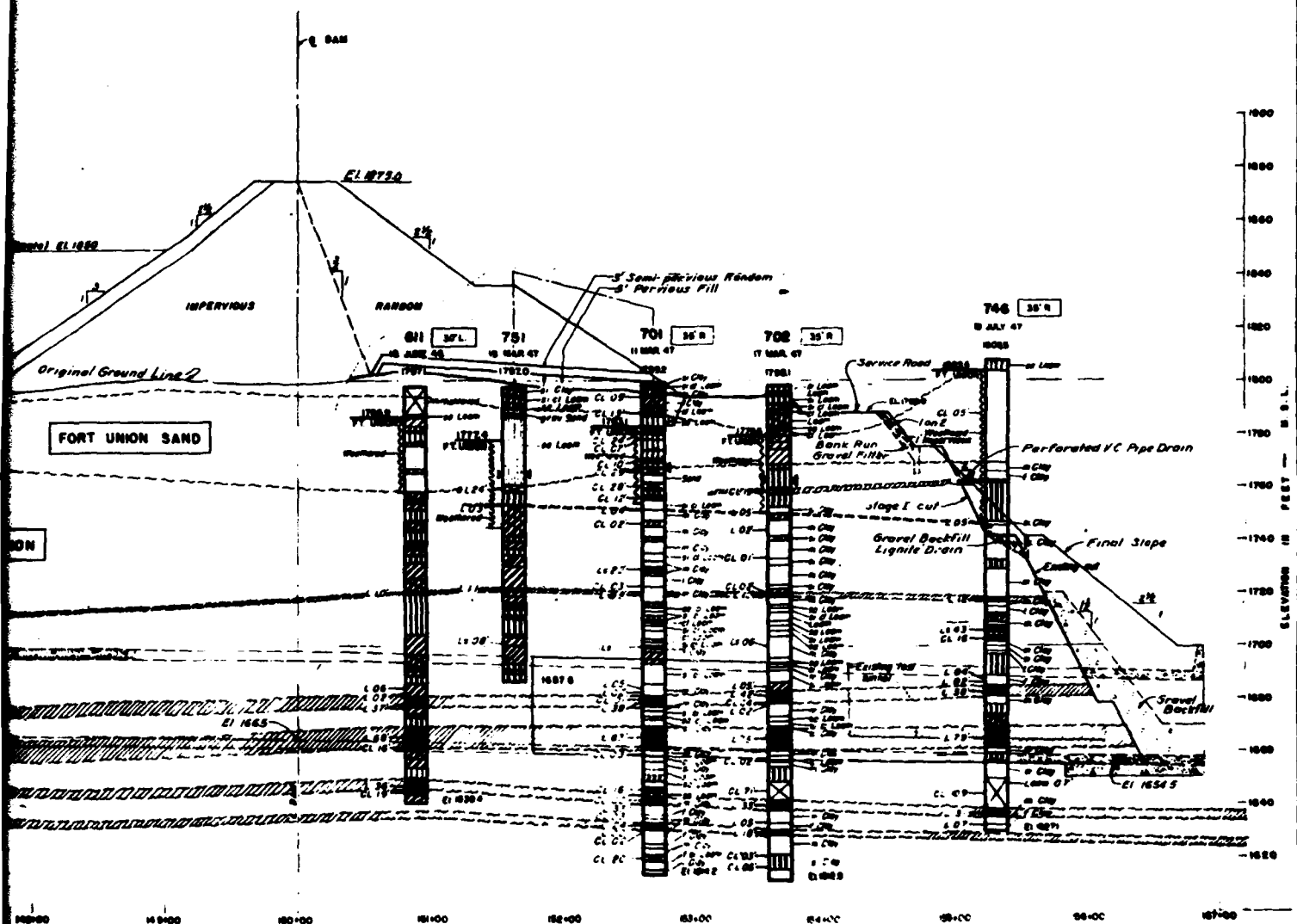
F/G 13/13

NL



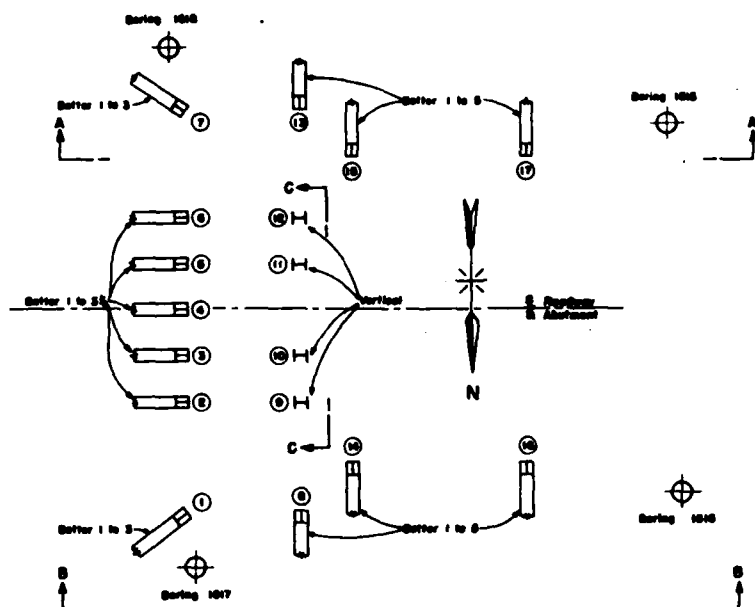


MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



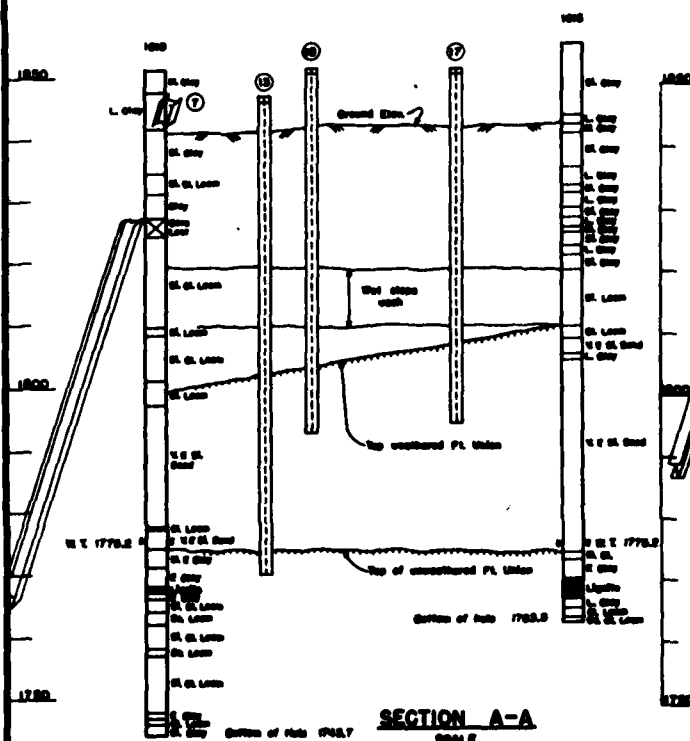
NOTE: SEE REVERSE SHEET

REV	DATE	REVISED BY	BY
U.S. DEPARTMENT OF COMMERCE OFFICE OF THE DISTRICT ENGINEER MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR          FOUNDATION PROFILE          TUNNELS</b>			
DRAWN BY CHECKED BY APPROVED BY		DATE MAY 1948 EX-8734	

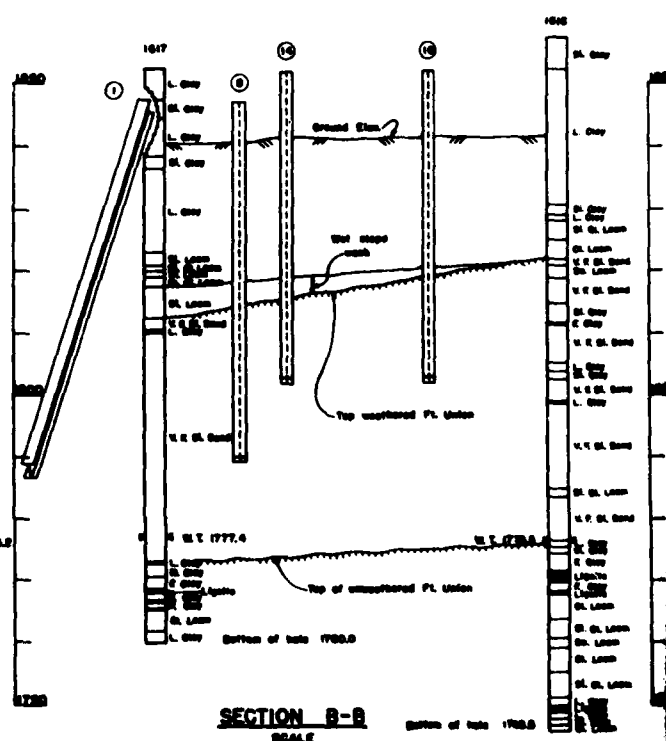


**PLAN**  
SCALE - 1"=15'

PILE NO.	DATE DRIVEN	NO. OF SPLICES	LENGTH (in Feet)		BATTERY	ELEVATION		
			OVERALL	OUT-OFF		OUT-OFF	TOP	CRANE
1	23, 24, 25 26 & 29 AUG.	2	72.0	0.0	02.1	1 to 3	1045.5	1702.7
2	22, 23 & 24 AUG.	2	60.2	0.1	75.1	1 to 3	1045.5	1714.5
3	22, 23, 24 25 & 29 AUG.	4	91.5	3.5	00.0	1 to 3	1045.5	1702.2
4	22, 23, 24 25 & 29 AUG.	3	84.2	5.4	00.5	1 to 3	1045.5	1702.1
5	22, 23, 24 25 & 29 AUG.	3	85.0	11.5	00.5	1 to 3	1045.5	1705.5
6	22, 23 & 27 AUG. & SEPT.	3	66.8	1.0	00.0	1 to 3	1045.5	1705.1
7	22, 27 & 30 AUG.	3	66.5	4.5	04.2	1 to 3	1045.5	1705.5
8	25, 29 & 30 AUG.	1	60.2	1.0	04.3	1 to 3	1045.5	1705.5
9	25, 27 & 30 AUG.	1	60.1	3.4	04.7	Vertical	1045.5	1700.1
10	21, 22, 24 25 & 30 AUG.	2	70.0	0.1	01.0	Vertical	1045.5	1704.5
11	21, 22, 23 24 & 24 AUG. & 2, 3, 6, 7 SEPT.	2	75.0	14.3	00.7	Vertical	1045.5	1705.1
12	22, 23 & 24 25 & 29 AUG.	2	75.2	15.3	00.9	Vertical	1045.5	1705.5
13	22, 27 & 30 AUG.	2	60.0	2.3	77.7	1 to 3	1045.5	1710.5
14	25 & 31 AUG. & SEPT.	1	60.0	10.0	00.0	1 to 3	1045.5	1802.3
15	30 AUG. & SEPT.	1	60.0	1.2	00.0	1 to 3	1045.5	1705.5
16	30 AUG. & SEPT.	1	60.1	10.0	00.1	1 to 3	1045.5	1802.2
17	5 SEPT.	1	60.0	2.0	57.2	1 to 3	1045.5	1705.5

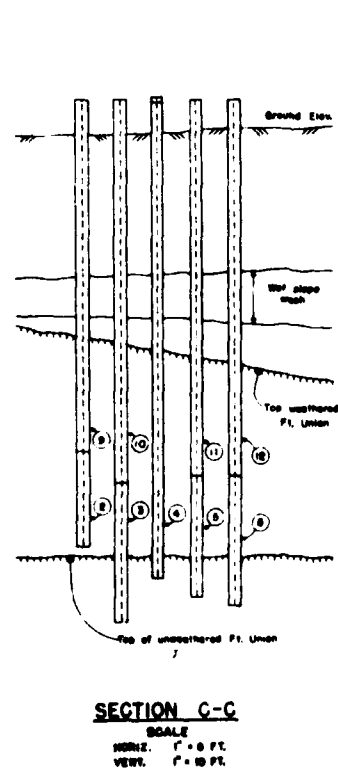
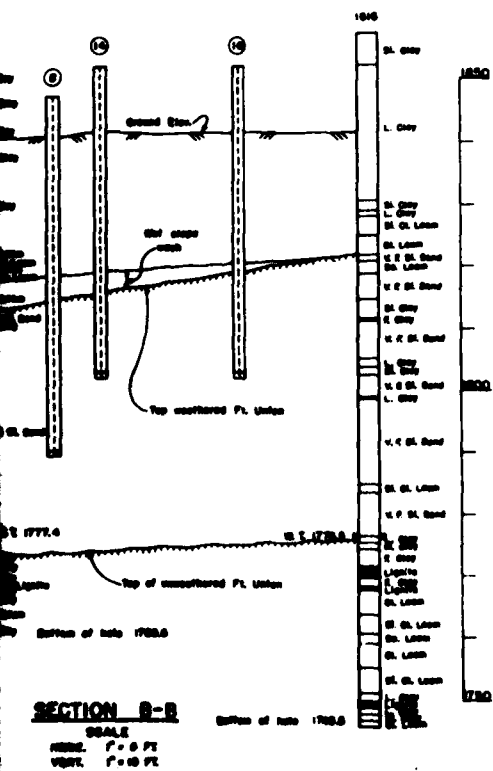


**SECTION A-A**  
SCALE  
HORIZ. 1"=15 FT  
VERT. 1"=15 FT



**SECTION B-B**  
SCALE  
HORIZ. 1"=15 FT  
VERT. 1"=15 FT

Pile No.	DATE DRIVEN	NO. OF PILES	LENGTH (in Feet)			ELEVATION			VERTICAL SETBACK (FEET)	BLOWS	AMOUNT INCHES	INCHES PER BLOW	BLOWS PER MINUTE	INDU- GATED CAPACITY (TONS)	DEVIATION				REMARKS
			GENERAL	OUT-OF-PLUM	PLUM	OUT-OF-PLUM	TYP	GROUND							N	S	E	W	
1	22, 24, 26 28 & 29 AUG.	2	72.0	0.9	52.1	1 to 3	1846.9	1787.9	1840.7	52.9		Refusal	120	156	.84'	.28'			Run pile hammer continuously at 120 blows per minute for 30 minutes on 22 August 1954 with no resulting movement of the pile.
2	22, 24, 26 28 & 29 AUG.	2	65.2	0.1	76.1	1 to 3 1/2	1846.9	1774.6	1840.9	66.3		Refusal	116	149	.77'	.08'			Run pile hammer continuously at 116 blows per minute for 15 minutes on 24 August 1954 with no resulting movement of the pile.
3	22, 24, 26 28 & 29 AUG.	4	91.6	3.6	59.0	1 to 3 1/2	1846.9	1762.2	1840.9	76.4		Refusal	116	149	.18'	.06'			Run pile hammer continuously at 116 blows per minute for 15 minutes on 29 August 1954 with no resulting movement of the pile. Top 2.5 feet of pile is 14" SP 73" piling applied to bring top to grade. No driving done on the 73" piling.
4	22, 24, 26 28 & 29 AUG.	3	64.2	3.4	50.8	1 to 3 1/2	1846.9	1769.1	1840.9	71.8	100	1/4	0.0019	112	140	.38'			A1'
5	22, 24, 26 28 & 29 AUG.	3	65.0	11.8	55.5	1 to 3 1/2	1846.9	1766.8	1840.9	74.4		Refusal	120	155	.58'				Run pile hammer continuously at 120 blows per minute for 15 minutes on 25 August 1954 with no resulting movement of the pile.
6	22, 24, 26 28 & 29 AUG.	3	66.8	1.2	56.0	1 to 3 1/2	1846.9	1765.1	1840.7	75.6	120	1/2	0.0042	120	149	.49'			A9'
7	22, 24, 26 28 & 29 AUG.	3	68.0	4.6	64.2	1 to 3	1846.9	1766.9	1841.2	74.3		Refusal	118	151	.22'				Final penetration of piling made at rate of 1/4 inch per 120 blows over a period of 15 minutes.
8	22, 24, 26 28 & 29 AUG.	1	65.2	1.0	56.3	1 to 5	1846.9	1768.6	1841.0	51.6		Refusal	112	143	.70'	.29'			Run pile hammer continuously at 112 blows per minute for 1 hour on 30 August 1954 with resulting movement of pile of only 1/4 inch.
9	22, 24, 26 28 & 29 AUG.	1	60.1	3.4	56.7	Vertical	1846.9	1780.1	1841.3	51.2		Refusal	116	151	.27'	.12'			Run pile hammer continuously at 116 blows per minute for 30 minutes on 30 August 1954 with no resulting movement of the pile.
10	21, 22, 24 26 & 29 AUG.	2	70.0	0.1	51.0	Vertical	1846.9	1784.9	1841.4	55.0		Refusal	112	144	.08'	.05'			Run pile hammer continuously at 112 blows per minute for 30 minutes on 30 August 1954 with no resulting movement of the pile.
11	21, 22, 24 26 & 29 AUG.	2	75.0	14.3	63.7	Vertical	1846.9	1785.1	1841.8	50.7		Refusal	120	157	0	0	0	0	Run pile hammer continuously at 120 blows per minute for 30 minutes on 3 September 1954 with no resulting movement of the pile.
12	22, 24, 26 28 & 29 AUG.	2	76.8	15.3	60.9	Vertical	1846.9	1785.9	1842.0	56.1		Refusal	120	157	.23'			.16'	Top 8.4 ft. of pile is 14" SP 73" piling. With pile hammer running at 120 blows per minute the last foot of driving was at a rate of one inch per 100 blows. The 14" SP 73" piling then started to buckle and when further penetration of the piling ceased, the driving was discontinued.
13	22, 24, 26 28 & 29 AUG.	2	60.0	2.3	77.7	1 to 5	1846.9	1770.6	1841.6	71.0		Refusal	116	150	.11'	.04'			Run pile hammer continuously at 116 blows per minute for 30 minutes on 30 August 1954 with no resulting movement of the pile.
14	22, 24, 26 28 & 29 AUG.	1	60.0	10.0	50.0	1 to 5	1846.3	1802.3	1841.7	38.4	30	1/4	0.0063	120	144	.31'	.22'		
15	22, 24, 26 28 & 29 AUG.	1	60.0	1.2	59.8	1 to 5	1846.3	1795.6	1842.8	48.2	30	1/2	0.0500	120	104	.06'	.07'		
16	22, 24, 26 28 & 29 AUG.	1	60.1	10.0	50.1	1 to 5	1846.3	1808.8	1842.0	36.8		Refusal	116	153	.17'	.06'			Run pile hammer continuously at 116 blows per minute for 30 minutes on 3 September 1954 with resulting movement of pile of only 1/4 inch.
17	5 SEPT	1	60.0	2.8	57.2	1 to 5	1846.3	1799.2	1842.9	47.7	40	1	0.0250	118	120	.26'		.16'	



### PILE DESIGN DATA

McKlemm-Terry 10-B-3 Pile Hammer

### ENGINEERING NEWS FORMULA

$$\text{Bearing Capacity} = \frac{S(E-K)}{F+0.3}$$

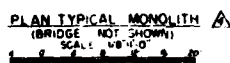
S = indicated penetration in inches per blow for last 50 blows

Stresses per minute	50	55	60	65	70	75	80
E = Ft. lbs. energy per blow	12,000	13,500	15,000	16,500	18,000	19,500	21,000
Factor of pile	1.2	1.3	1.4	1.5	1.6	1.7	1.8
E = Ft. lbs. energy last per blow	2041	2250	2459	2668	2877	3086	3295

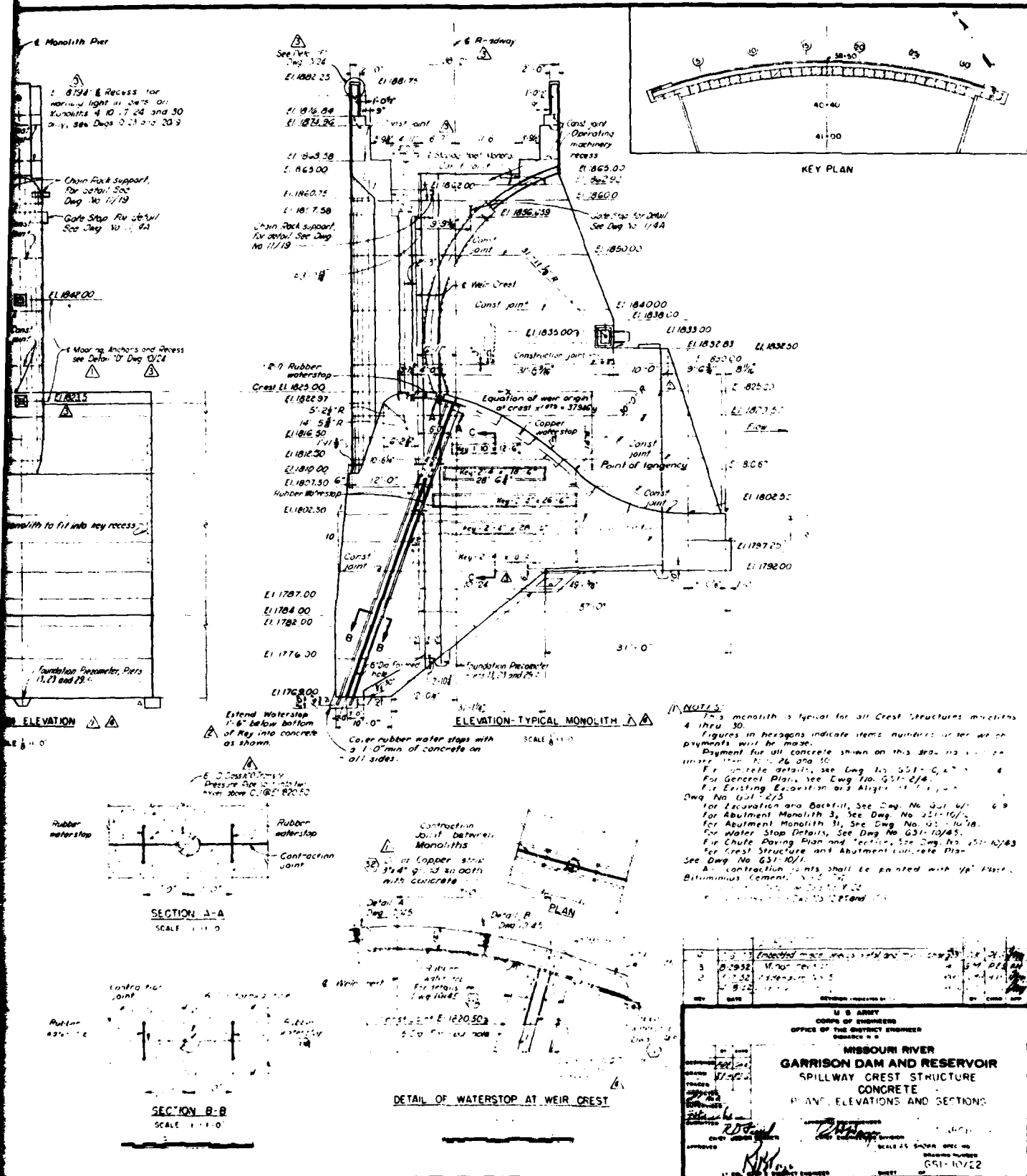
### GENERAL NOTES:

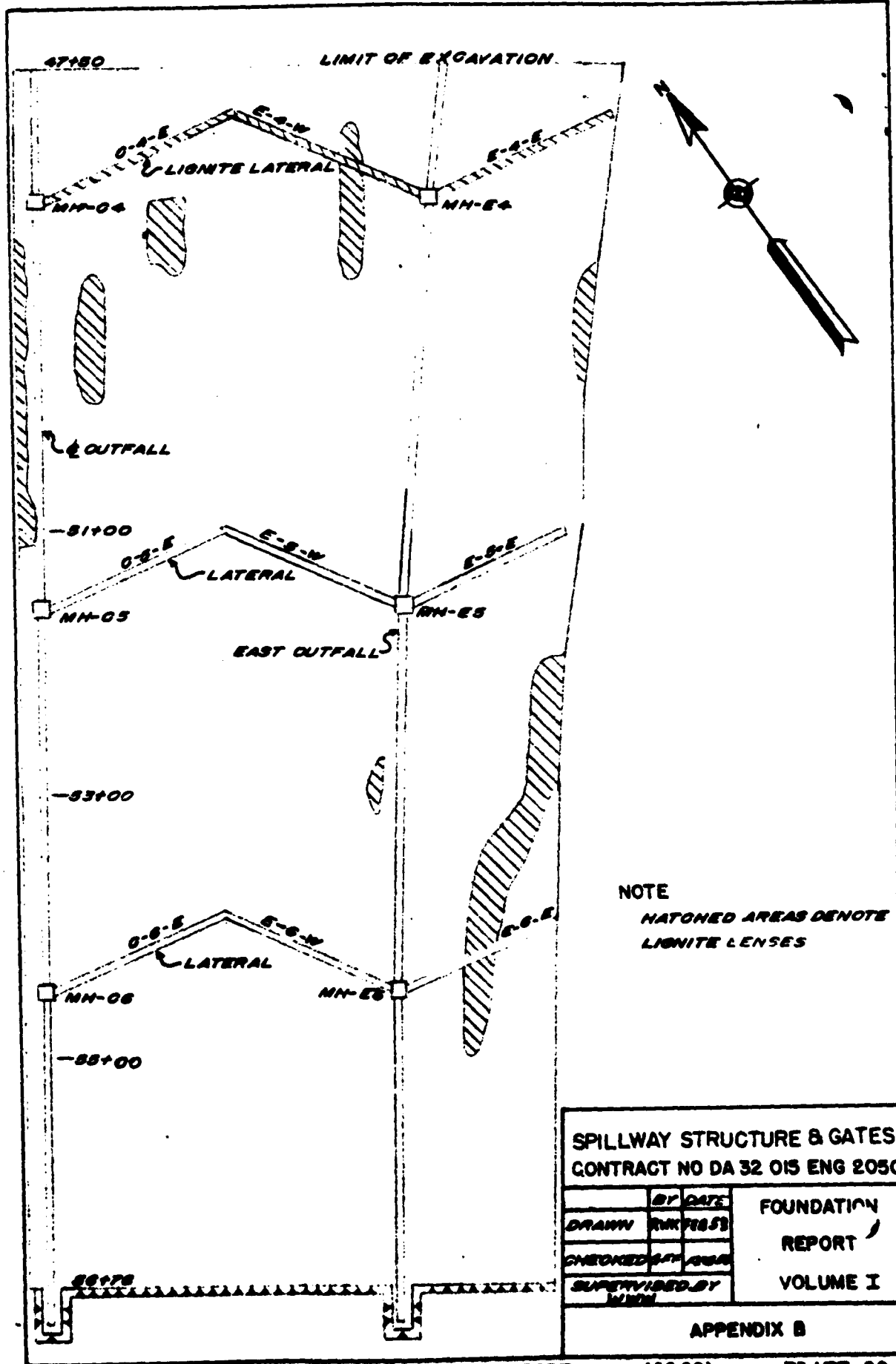
- Used McKlemm-Terry 10-B-3 double-acting pile hammer on all piling.
- All piling furnished was in 50-foot lengths except the 73" piling which was in 30 ft. lengths. The first splice on each pile was made after driving the initial 20 ft. or 30 ft. section. Piles 1 thru 13 are 14" SP 117" piling. Piles 14 thru 17 are 14" SP 73" piling. 50-inch diameter sheet piles were driven 50 ft. deep for piles 1 thru 13, 15 ft. for pile 14, and 10 ft. for piles 15 thru 17. Upon completion of driving operations these holes were back filled with sand. All elevations are to 1/4 of piling. Deviations measured with respect to 1/4 of top of bearing plates.

GARRISON DAM AND RESERVOIR INTAKE SERVICE BRIDGE ABUTMENT		PILE DRIVING DATA	
DATE	22 SEP 54	BY	W. J. H. H.
GARRISON DAM AND RESERVOIR INTAKE SERVICE BRIDGE ABUTMENT			
PILE DRIVING DATA			
DATE	22 SEP 54	BY	W. J. H. H.
GARRISON DAM AND RESERVOIR INTAKE SERVICE BRIDGE ABUTMENT			
PILE DRIVING DATA			
DATE	22 SEP 54	BY	W. J. H. H.



SECTION B-B  
SCALE 1" = 1'-0"

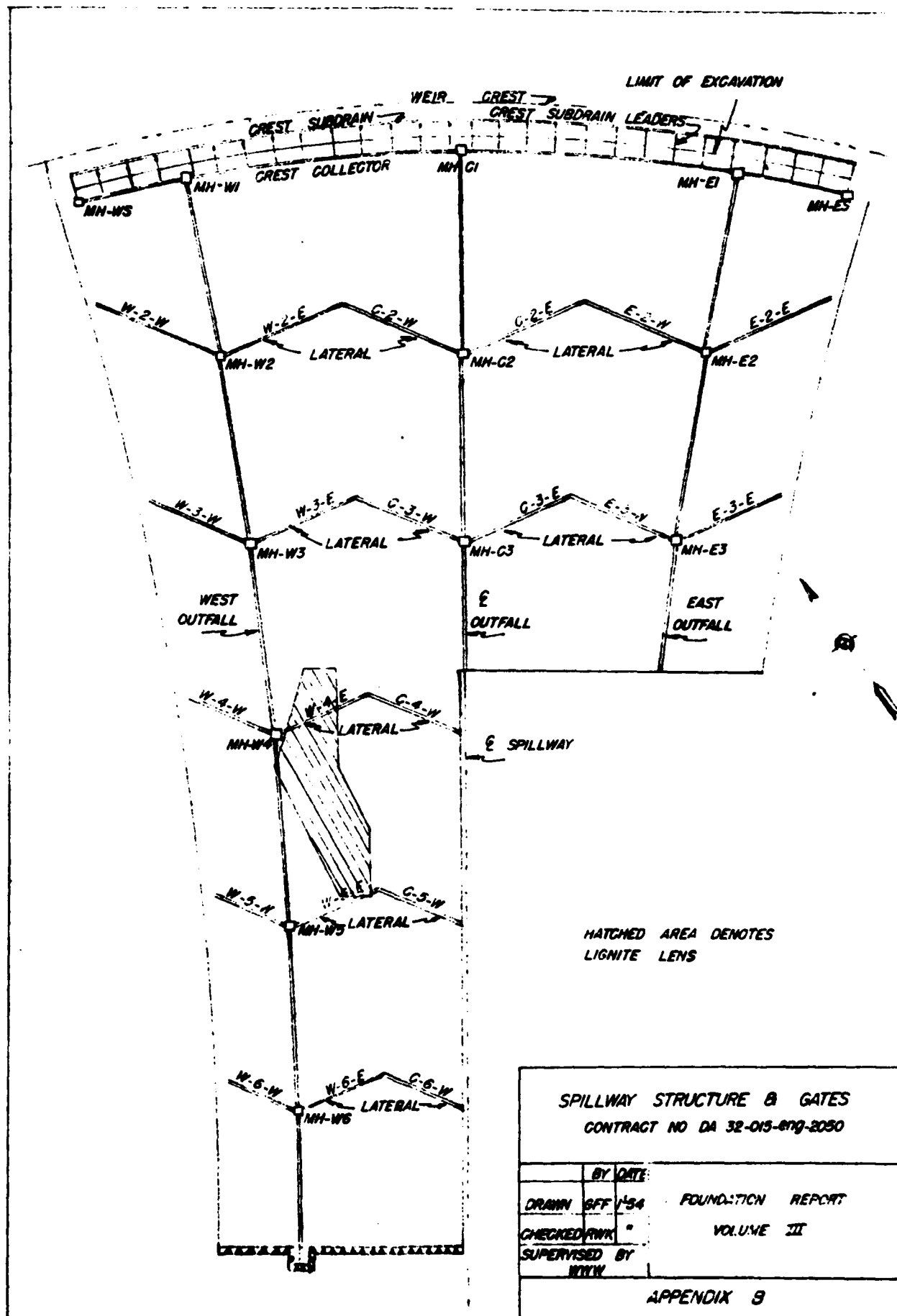




**SPILLWAY STRUCTURE & GATES**  
**CONTRACT NO DA 32 015 ENG 2050**

	BY	DATE	FOUNDATION REPORT VOLUME I
DRAWN	RW	1/85	
CHECKED	AT	1/85	
SUPERVISED BY	WJH		
APPENDIX B			



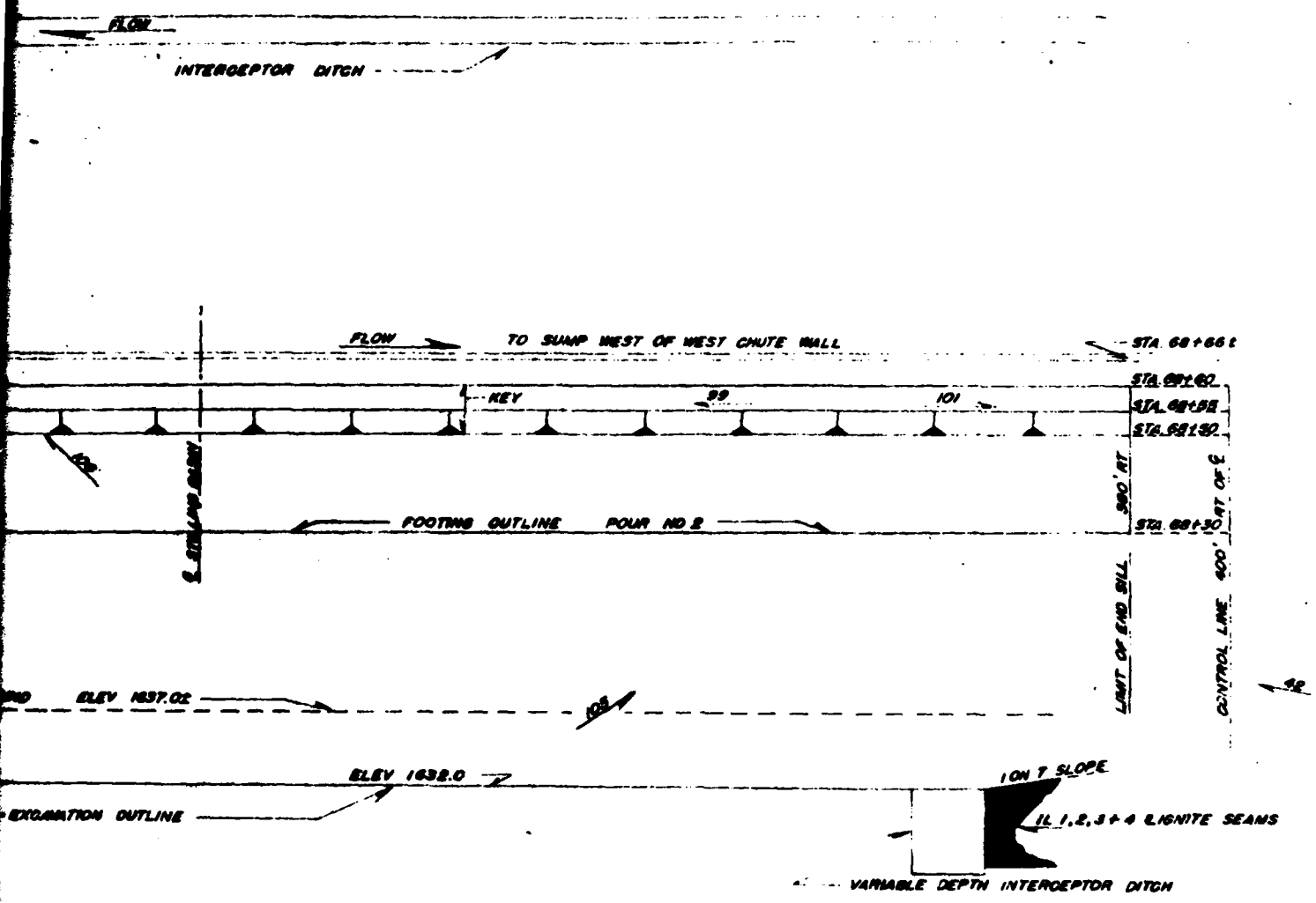


SPILLWAY STRUCTURE & GATES  
CONTRACT NO DA 32-013-070-2050

BY	DATE	
DRAWN	BFF 1/54	FOUNDATION REPORT
CHECKED	RWK "	VOLUME III
SUPERVISED BY	WYV	

APPENDIX B



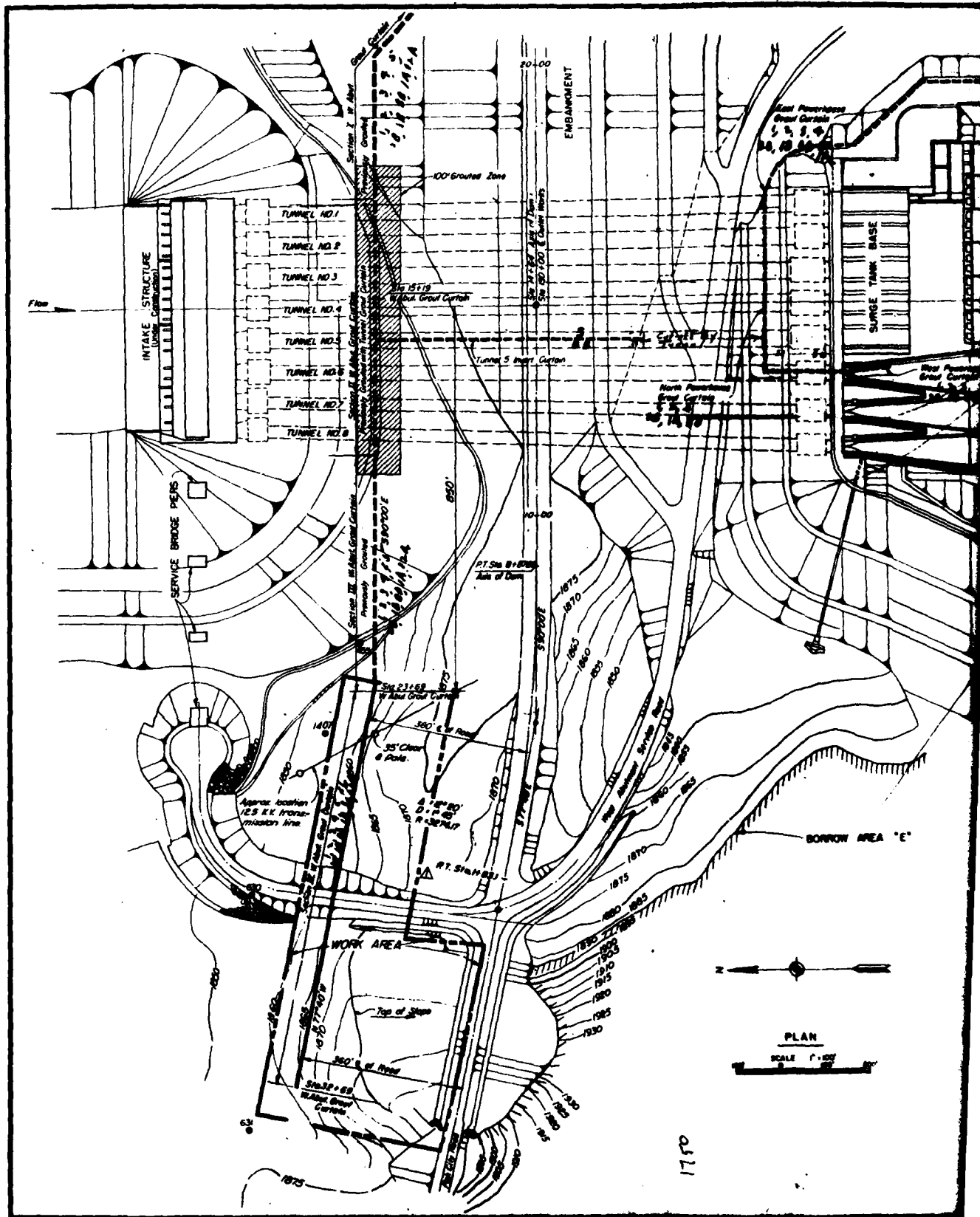


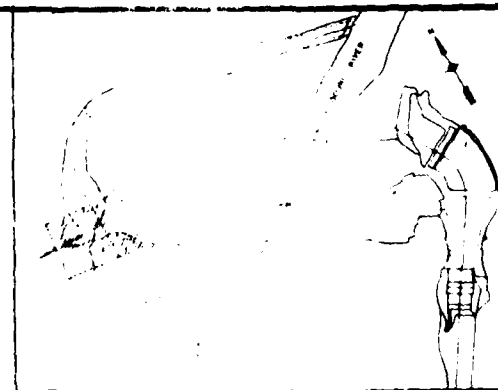
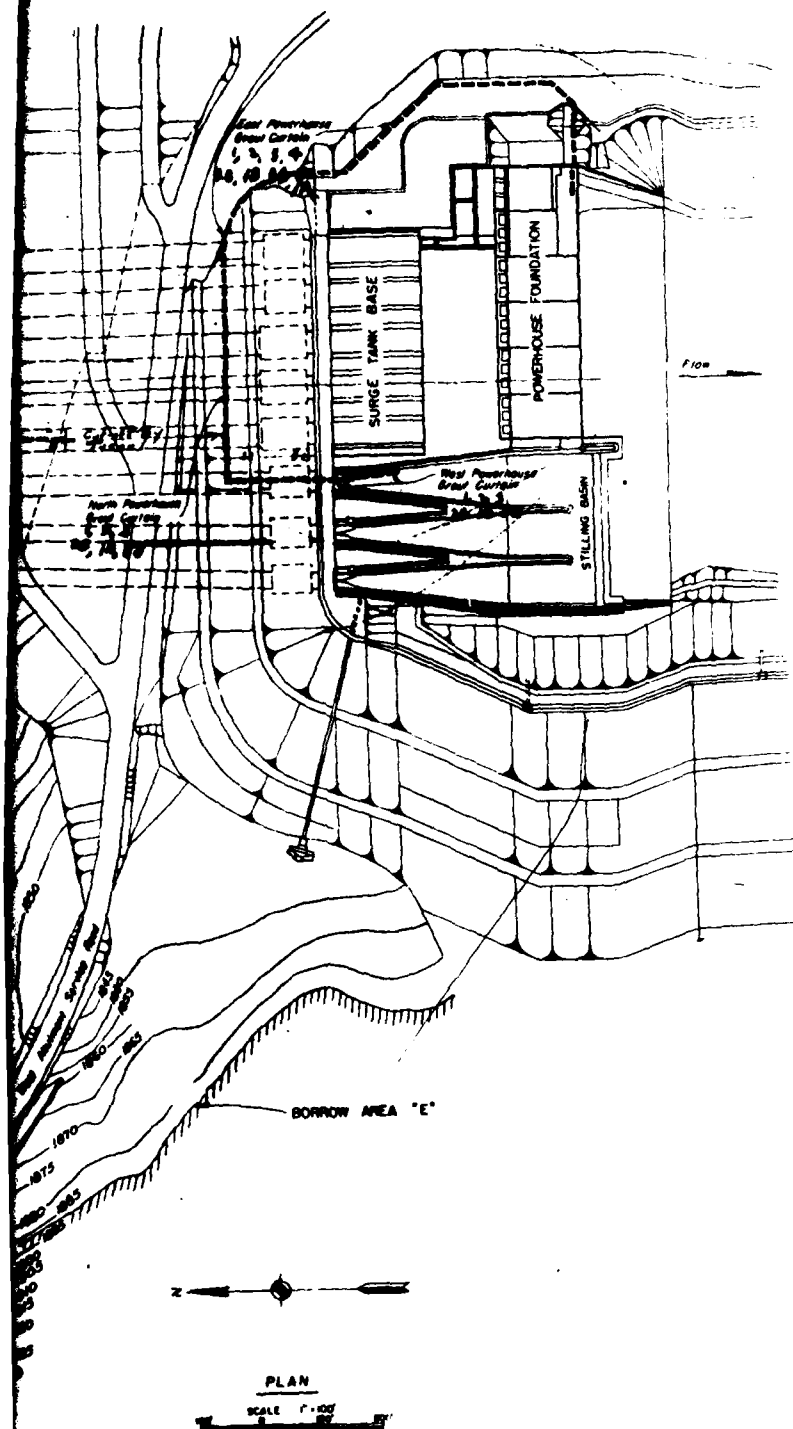
### LOCATION SKETCH

1. LIMITS OF EXCAVATION OUTLINE
2. LOCATION AND DIRECTION OF PICTURES IN APPENDIX B

<b>SPILLWAY STILLING BASIN</b>			
CONTRACT NO. A-32-08-ENG-3008			
BY	DATE	<b>FOUNDATION REPORT VOLUME I</b>	
CHECKED BY	DATE		
DESIGNED BY	DATE		
SUPERVISED BY		DATE	

2





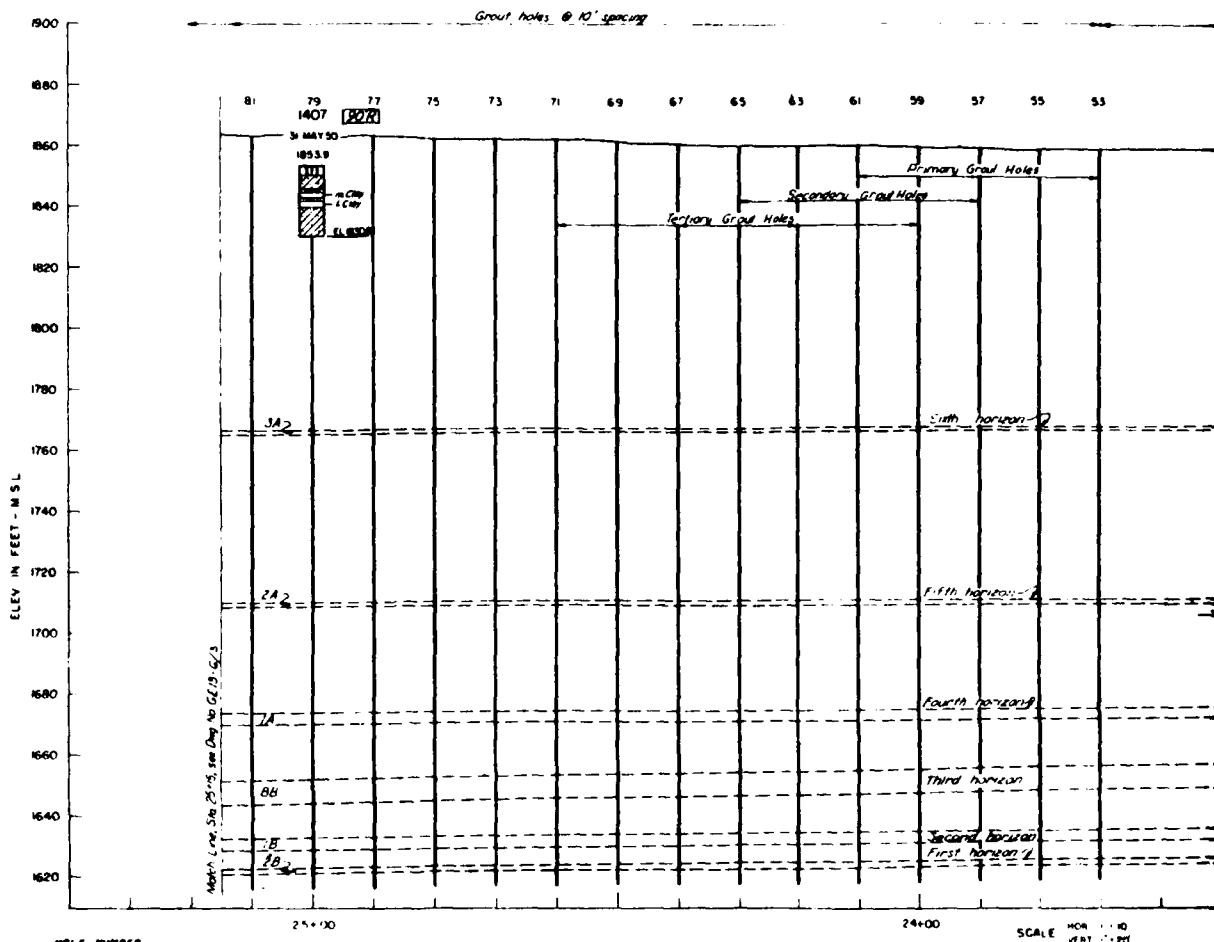
# INDEX TO DRAWINGS

DESCRIPTION	DWG. NO.
PLAN	3E13-6/1
STA 23+00 TO STA 24+00	3E13-6/2
STA 25+00 TO STA 26+00	3E13-6/3
STA 27+00 TO STA 28+00	3E13-6/4
STA 29+00 TO STA 30+00	3E13-6/5

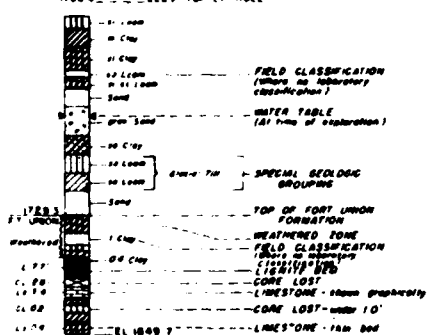
# NOTES

1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE U.S. ARMY CORPS OF ENGINEERS, WASHINGTON, D.C., 1947, AND THE LATEST EDITION OF THE U.S. ARMY CORPS OF ENGINEERS, WASHINGTON, D.C., 1947, AND THE LATEST EDITION OF THE U.S. ARMY CORPS OF ENGINEERS, WASHINGTON, D.C., 1947.

DATE	1/2/53
BY	W. J. H. H.
CHECKED BY	W. J. H. H.
APPROVED BY	W. J. H. H.
GARRISON DAM AND RESERVOIR	
W. J. H. H.	
MARCH 1953	
3E13-6/1	



87 HOLE NUMBER  
25 MAR 43 DATE HOLE COMPLETED  
1700 ELEV. TOP OF HOLE



gr - gravelly  
s - sandy  
sl - silty  
cl - clayey

L - lean (clay)  
m - medium (clay)  
f - fat (clay)

Lean, medium & fat clays are not differentiated in Fort Union.

Fine, medium & coarse sands are not differentiated in both overburden and Fort Union, strata less than 10' thick not shown, being combined with the most similar material above or below based on thickness of 0.1' are indicated for lignite, limestone, core loss, and foreign material within a segregable lignite bed.

#### LEGEND

##### GRAIN SIZE SYMBOLS



Symbols represent grain size distribution, predominant types by heavy lines, modifying types by light lines

##### OTHER SYMBOLS



#### LEGEND FOR PROJECTED HOLES

40 R indicates a hole located 40' to the right of profile, relative to direction of increase in stationing. Similarly, L stands for left of profile, U, upstream, and D, downstream, are used in instances where R & L are not applicable.

741 indicates completed borings

#### DESCRIPTIVE NOTES

**Fort Union Formation** is a Tertiary clay-siltstone. It consists of a series of continuously deposited compact, clay to sandy materials, arranged in gently dipping beds (often cross bedded), which range from thin partings to 15' or more in thickness. Clayey phases are predominant.

Within the formation there are horizons of **lignite**, **stone**, and **sandstone**, which may reach a thickness of about 5'. Often these horizons are discontinuous in the form of concretions which may attain a thickness of 5' or more and may be greater than 25' in diameter.

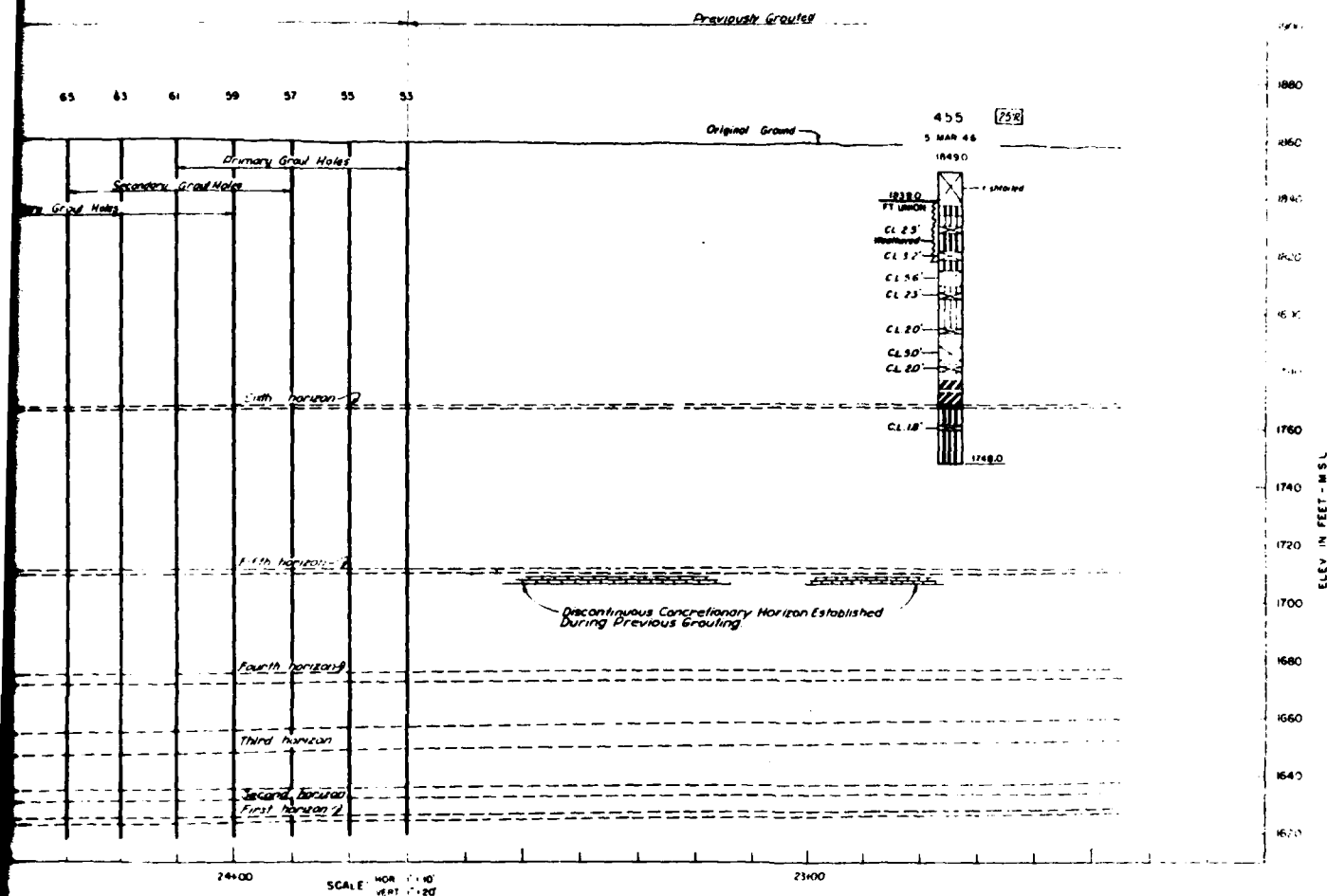
**Lignite** beds vary in thickness from thin partings to over 10', and are usually water bearing, particularly the thicker beds.

Boring of lignite beds has in places colored and hardened adjacent materials when exposed these have a pinkish color and are locally known as **ash**.

The **ash** formation is an unsorted mixture, graded largely from sand sizes to clay sizes, generally deposited in a compact state generally characterized by a small percentage of pebbles having a usual maximum size of one inch. Occasional cobbles and boulders are also found in the fill.

**Lignite float** indicates the presence of various sized pieces of lignite transported and mixed by stream action and found deposited in varying concentrations at irregular horizons in the glacial or alluvial materials.

The term **lean** is used to designate a mixture of sand, silt and clay sizes, the percentage of clay sizes ranging from 0 to 19 for lean and from 20 to 29 for clay lean, with predominant remaining material indicated by a modifying adjective. The term **lean** does not imply the dominance of organic material.



#### DESCRIPTIVE NOTES

**Fort Union Formation** is a tertiary clay-shale it consists of a series of continuously deposited compact, clayey to sandy materials, arranged in gently dipping beds (often cross bedded), which range from thin partings to 15' or more in thickness. Clayey phases are predominant.

Where the formation there are horizons of **limonite** and **glaucous** which may reach a thickness of about 5'. Other these horizons are discontinuous in the form of concretions which may attain a thickness of 5' or more and may be greater than 25' in diameter.

**Lignite** beds vary in thickness from thin partings to over 10' and are usually water bearing, particularly the thicker beds.

Bearing of **lignite** beds has in places covered and hardened adjacent materials. When exposed these have a pinkish color and are locally known as **ashles**.

The **glacial till** formation is an unsorted mixture, graded largely from sand sizes to clay sizes, generally deposited in a compact state generally characterized by a small percentage of pebbles having a usual maximum size of one inch. Occasional cobbles and boulders are also found in the till.

**Lignite flag** indicates the presence of various sized pieces of lignite transported and mixed by stream action and found deposited in varying concentrations of irregular horizons in the glacial or alluvial materials.

The **loom** term is used to designate a mixture of sand, silt and clay sizes, the percentage of clay sizes ranging from 0 to 10 for loam and from 20 to 25 for clay loam, with predominant remaining material indicated by a modifying adjective. The term loam does not imply the admixture of organic material.

#### GENERAL NOTES

Indicated water table elevations, although derived from best available data, should be regarded as approximate only and subject to considerable variations.

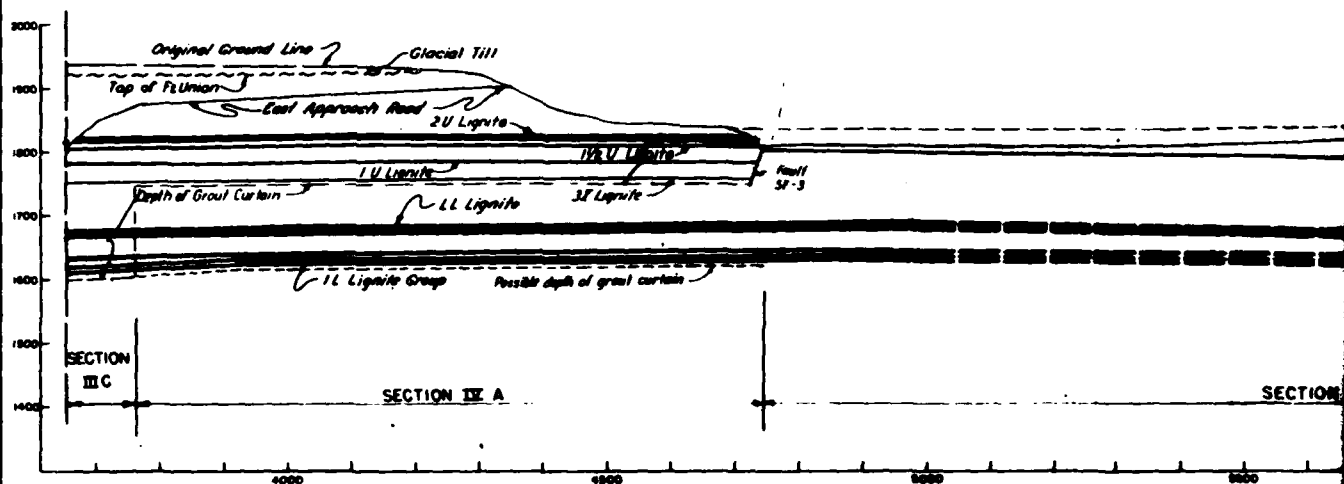
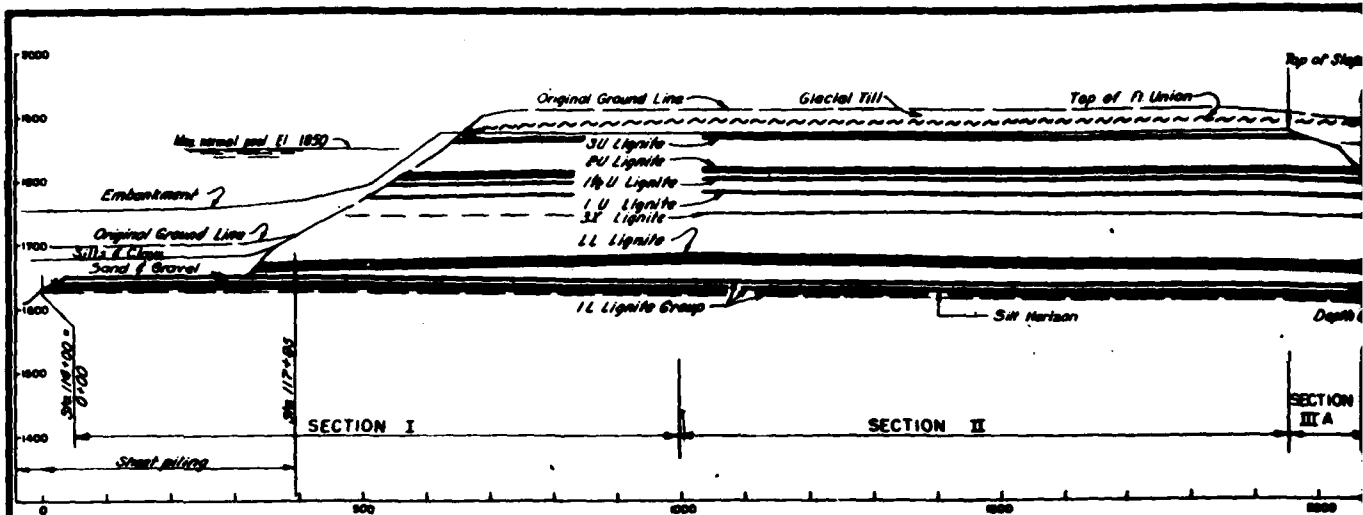
Available samples may be inspected at the Corps of Engineers Office of the District.

Graphic logs give bearing information in condensed form. Further information is shown in the complete boring logs which may be inspected at the Corps of Engineers Office at the site.

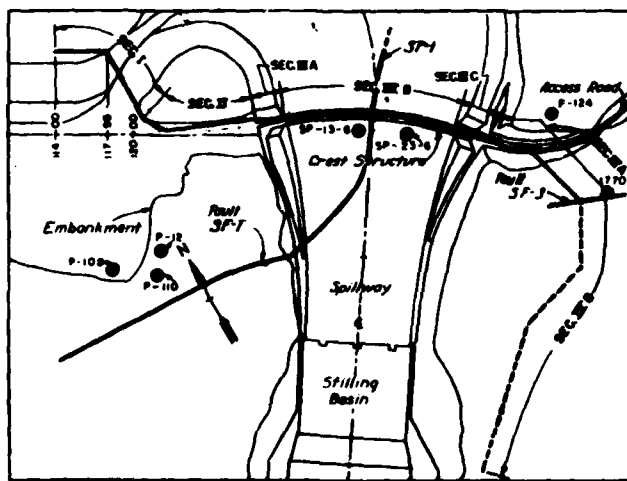
Generally borings in overburden made by churn type rig using 6-inch inside diameter open end drive tube. Continuous samples recovered. Generally borings in Fort Union made by rotary type rig using double tube core barrel. Continuous core 3 1/2 inches in diameter recovered.

#### NOTES

For Plan, see Diagram 16.1  
Corrections: 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 17.0, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 18.0, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9, 19.0, 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8, 19.9, 20.0, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 21.0, 21.1, 21.2, 21.3, 21.4, 21.5, 21.6, 21.7, 21.8, 21.9, 22.0, 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9, 23.0, 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7, 23.8, 23.9, 24.0, 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, 24.9, 25.0, 25.1, 25.2, 25.3, 25.4, 25.5, 25.6, 25.7, 25.8, 25.9, 26.0, 26.1, 26.2, 26.3, 26.4, 26.5, 26.6, 26.7, 26.8, 26.9, 27.0, 27.1, 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 28.0, 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, 28.7, 28.8, 28.9, 29.0, 29.1, 29.2, 29.3, 29.4, 29.5, 29.6, 29.7, 29.8, 29.9, 30.0, 30.1, 30.2, 30.3, 30.4, 30.5, 30.6, 30.7, 30.8, 30.9, 31.0, 31.1, 31.2, 31.3, 31.4, 31.5, 31.6, 31.7, 31.8, 31.9, 32.0, 32.1, 32.2, 32.3, 32.4, 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98.9, 99.0, 99.1, 99.2, 99.3, 99.4, 99.5, 99.6, 99.7, 99.8, 99.9, 100.0, 100.1, 100.2, 100.3, 100.4, 100.5, 100.6, 100.7, 100.8, 100.9, 101.0, 101.1, 101.2, 101.3, 101.4, 101.5, 101.6, 101.7, 101.8, 101.9, 102.0, 102.1, 102.2, 102.3, 102.4, 102.5, 102.6, 102.7, 102.8, 102.9, 103.0, 103.1, 103.2, 103.3, 103.4, 103.5, 103.6, 103.7, 103.8, 103.9, 104.0, 104.1, 104.2, 104.3, 104.4, 104.5, 104.6, 104.7, 104.8, 104.9, 105.0, 105.1, 105.2, 105.3, 105.4, 105.5, 105.6, 105.7, 105.8, 105.9, 106.0, 106.1, 106.2, 106.3, 106.4, 106.5, 106.6, 106.7, 106.8, 106.9, 107.0, 107.1, 107.2, 107.3, 107.4, 107.5, 107.6, 107.7, 107.8, 107.9, 108.0, 108.1, 108.2, 108.3, 108.4, 108.5, 108.6, 108.7, 108.8, 108.9, 109.0, 109.1, 109.2, 109.3, 109.4, 109.5, 109.6, 109.7, 109.8, 109.9, 110.0, 110.1, 110.2, 110.3, 110.4, 110.5, 110.6, 110.7, 110.8, 110.9, 111.0, 111.1, 111.2, 111.3, 111.4, 111.5, 111.6, 111.7, 111.8, 111.9, 112.0, 112.1, 112.2, 112.3, 112.4, 112.5, 112.6, 112.7, 112.8, 112.9, 113.0, 113.1, 113.2, 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184.8, 184.9, 185.0, 185.1, 185.2, 185.3, 185.4, 185.5, 185.6, 185.7



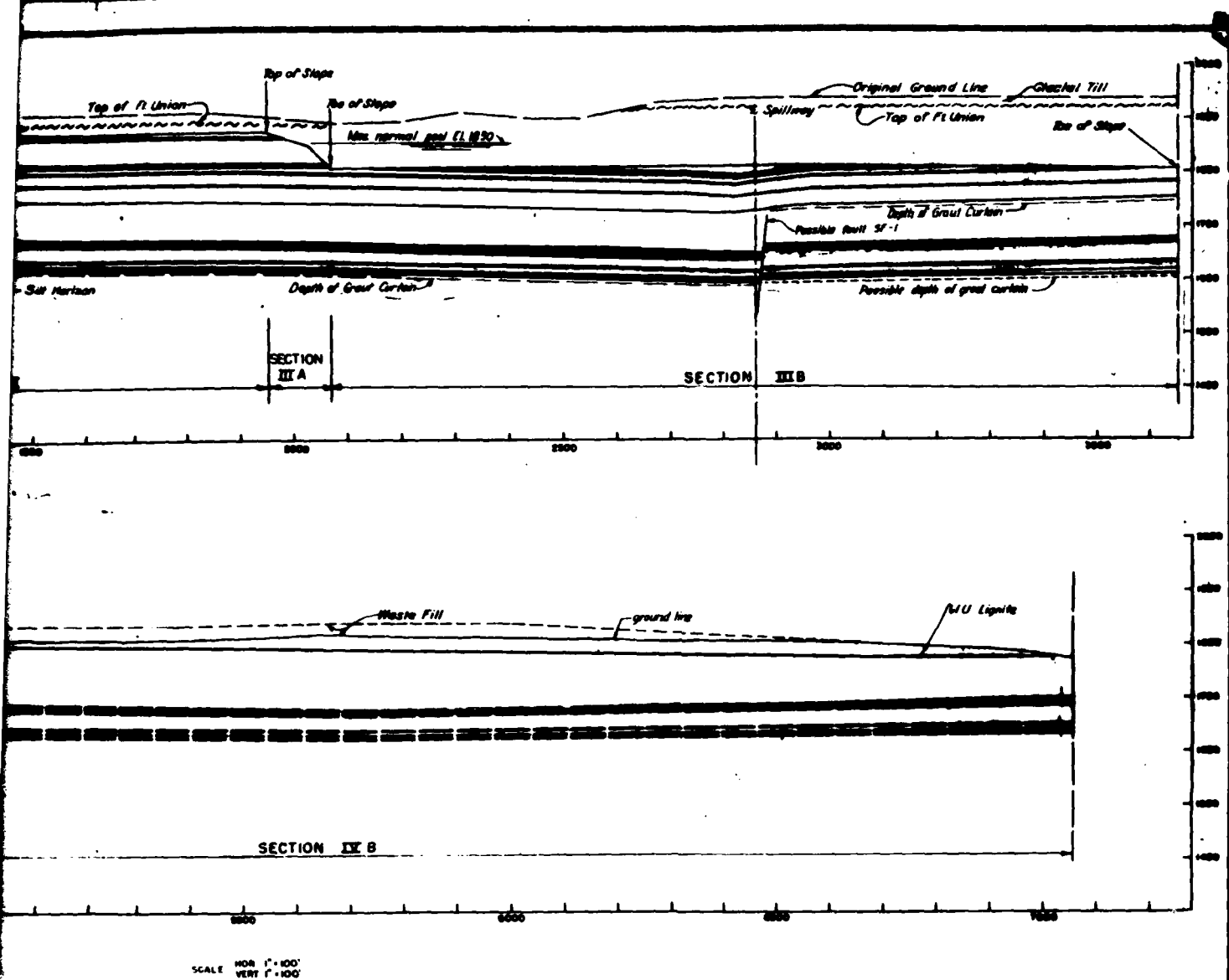
SCALE HOR 1"=100'  
VERT 1"=100'



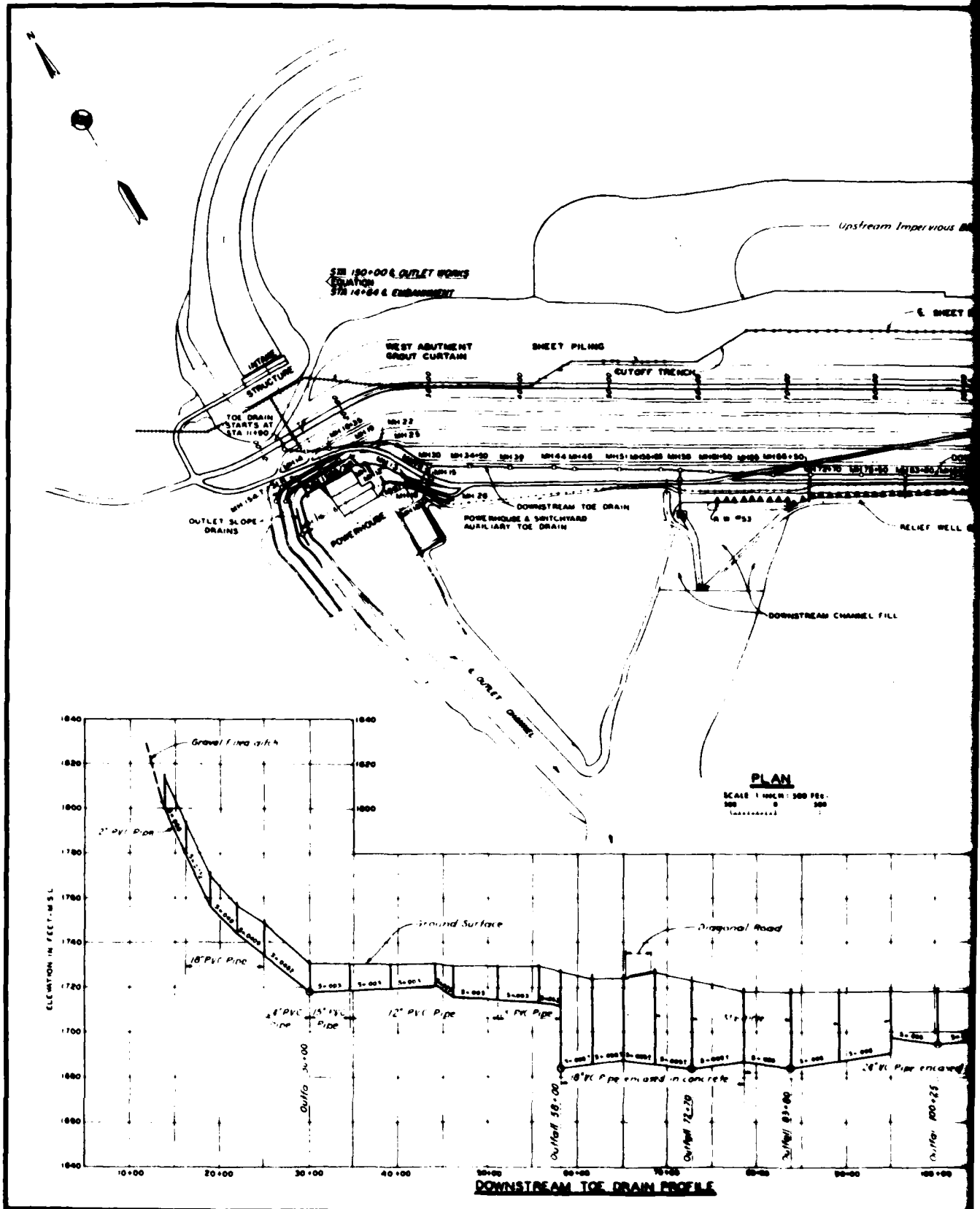
LOCATION PLAN

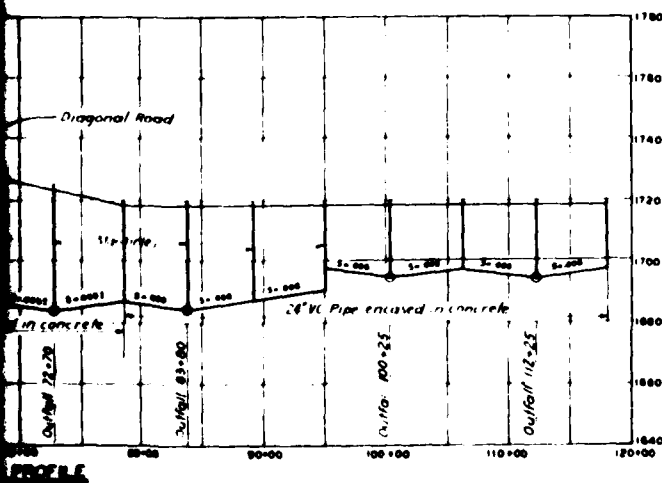
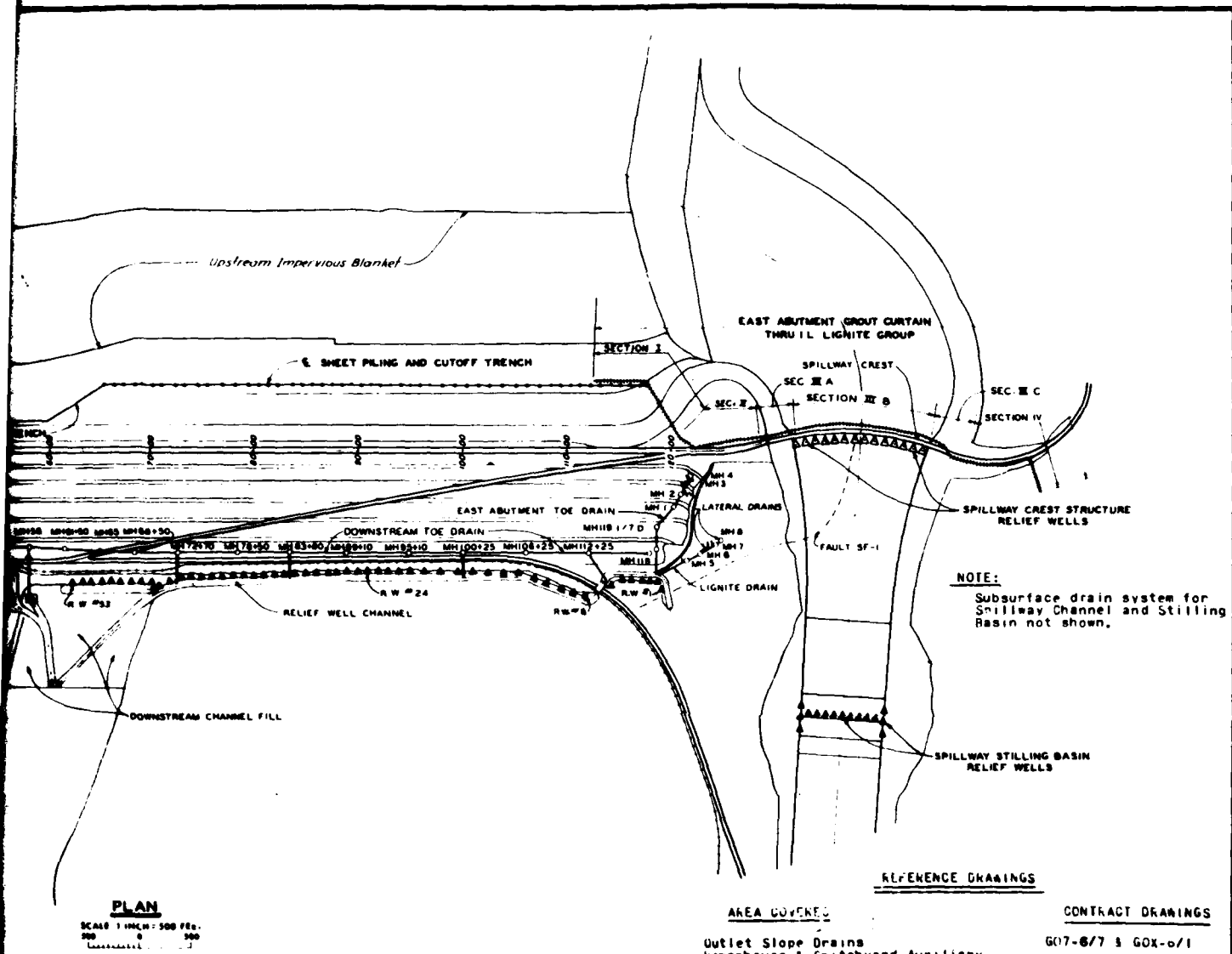
SCALE 1"=100'





1. <i>General</i>		<i>APR 12 1988</i>	
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MINNAPOLIS, MINN.			
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY GENERALIZED GEOLOGIC PROFILE EAST ABUTMENT GROUT CURTAIN			
<i>APR 12 1988</i>		<i>APRIL 1988</i>	
<i>Ray G. Sanchez</i>		<i>600-5700</i>	





#### REFERENCE DRAWINGS

#### AREA COVERED

#### CONTRACT DRAWINGS

Outlet Slope Drains  
 Powerhouse & Switchyard Auxiliary  
 Toe Drain  
 East Abutment Toe & Lignite Drains

GE17-6/7 & GOK-6/1  
 GE10-7/42 & G13-6/16  
 GE10-6/10 & G/11

#### Downstream Toe Drain Drawings

#### Embankment Stage

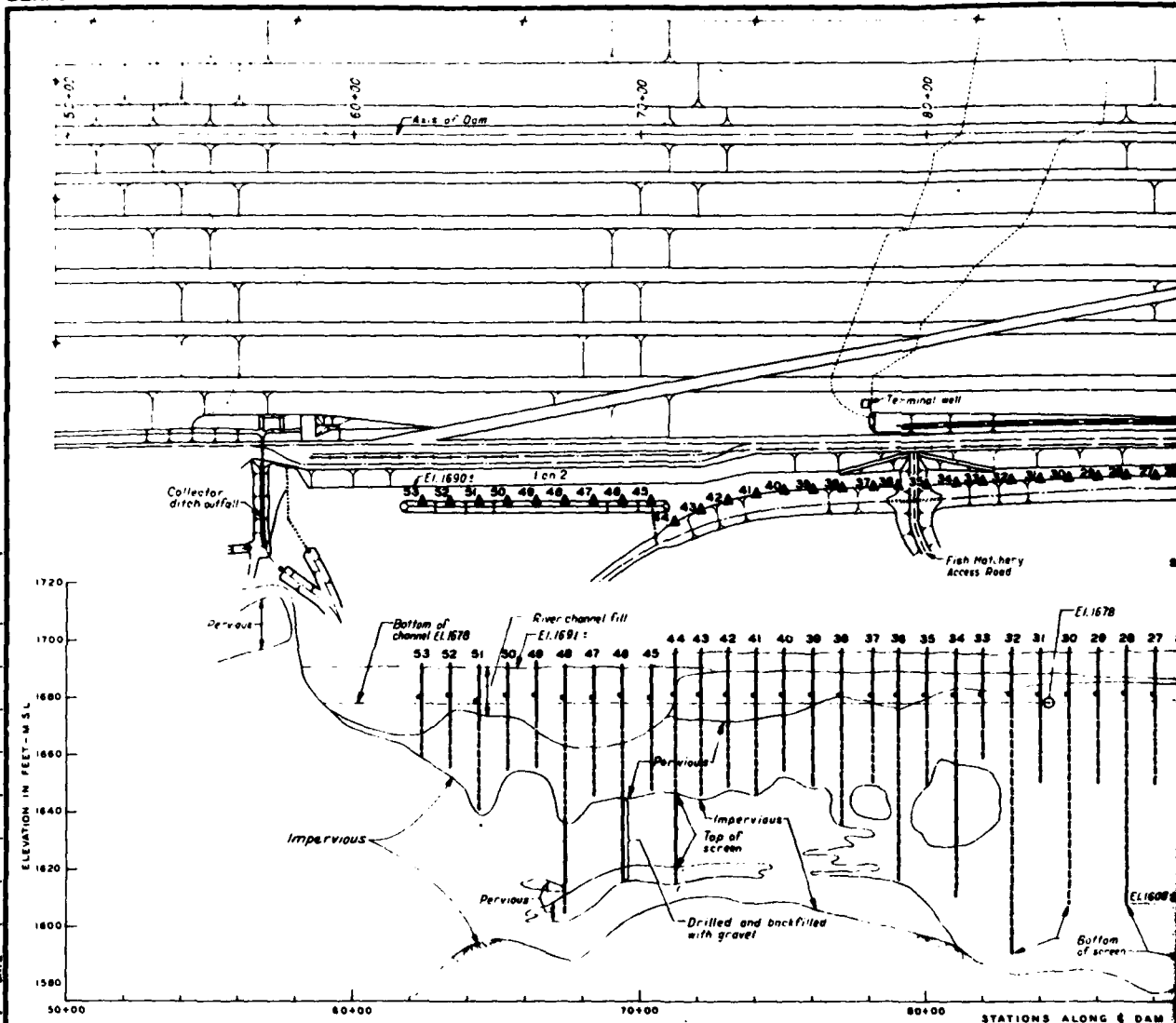
#### Area Covered

#### Contract Drawings

I  
 II  
 III  
 IV

Sta. 11+90 to 25+90	GE1-7/3
Sta. 25+90 to 55+00	GE3-6/1, 6/3, & 6/5
Sta. 55+00 to 60+20	GE6-6/1 & 6/2
Sta. 60+20 to 76+50	GE10-6/5 thru 6/8
	GE17-6/1 & 6/2

DESCRIPTION		DATE	BY	CHKD	APPD
U. S. ARMY ENGINEER DISTRICT, OMAHA					
CORPS OF ENGINEERS					
OMAHA DISTRICT					
MISSOURI RIVER					
GARRISON DAM AND RESERVOIR					
UNDERSEEPAGE STUDIES					
SEEPAGE CONTROL AND DOWNSTREAM					
TOE DRAIN PROFILE					
DESIGNED BY	L. J. ...	DATE	11/7/73		
CHECKED BY	...	DATE	...		
APPROVED BY	...	DATE	...		

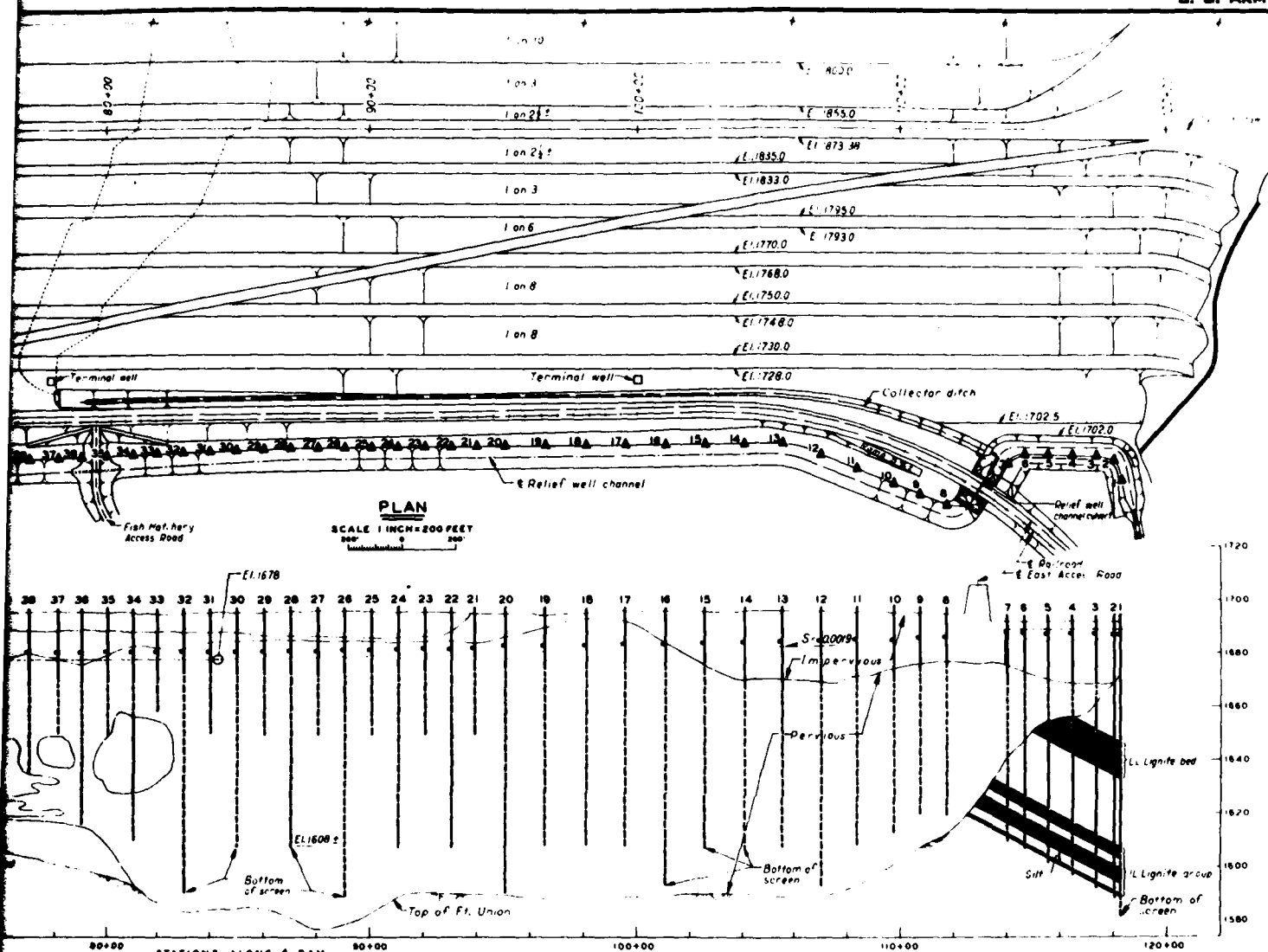


**GENERALIZED GEOLOGIC**  
(CONDITIONS BETWEEN BORINGS ESTD.)  
SCALE VERT. 1"=20'  
HORIZ. 1"=200'

Relief Well No.	Location Sta.	Offset	Depth of Well	Elevation Top of River	Elevation Invert of Outfall	Pipe Length - Feet	Bottom Elevation
1	118 + 31	1731.2	118.3	1694.11	1686.61	20.67	1581.8
2	118 + 01	1748.2	106.0	1694.47	1686.61	20.67	1581.5
3	117 + 38	1811.0	102.3	1694.88	1686.97	20.67	1582.0
4	116 + 46	1811.7	97.3	1694.36	1686.86	20.67	1587.1
5	115 + 38	1812.7	92.3	1694.33	1686.86	20.67	1587.1
6	114 + 69	1812.7	87.1	1694.08	1687.08	20.67	1587.0
7	114 + 01	1844.9	86.8	1694.47	1687.47	20.67	1589.7
8	111 + 76	1848.7	77.6	1697.31	1689.71	15.82	1639.7
9	110 + 76	1779.9	77.6	1697.37	1689.67	15.07	1680.0
10	109 + 79	1780.7	82.0	1698.01	1689.81	16.37	1683.0
11	108 + 39	1803.9	89.5	1697.74	1689.80	16.97	1688.2
12	107 + 01	1809.3	104.0	1697.31	1689.21	16.87	1693.3
13	105 + 39	1784.2	89.7	1697.39	1689.89	16.87	1687.9
14	104 + 08	1788.4	90.1	1697.76	1689.76	17.18	1687.7
15	102 + 08	1788.2	90.0	1697.61	1689.61	17.28	1687.6
16	101 + 08	1788.7	93.7	1697.27	1689.27	17.35	1687.4
17	99 + 39	1789.9	89.5	1697.38	1689.38	17.35	1687.1
18	98 + 09	1787.0	89.2	1697.08	1689.08	17.46	1686.8
19	96 + 38	1787.2	89.4	1697.48	1689.48	16.36	1686.2
20	95 + 08	1787.0	107.0	1697.48	1689.48	16.16	1686.1
21	93 + 08	1788.7	87.4	1697.48	1689.48	16.16	1686.0
22	93 + 08	1789.7	90.0	1697.35	1689.35	16.07	1687.5
23	92 + 08	1789.3	47.9	1697.76	1689.46	19.48	1689.9
24	92 + 08	1789.7	90.0	1697.86	1689.86	19.76	1689.8
25	90 + 08	1789.4	57.3	1697.80	1689.80	19.38	1689.9
26	89 + 08	1789.3	108.3	1697.80	1689.80	19.08	1689.3
27	88 + 07	1789.8	47.9	1697.77	1689.67	19.86	1689.9
28	87 + 07	1789.7	89.9	1697.75	1689.65	19.84	1687.9
29	86 + 07	1789.4	47.3	1697.23	1689.33	20.07	1689.9

Relief Well No.	Location Sta.	Offset	Depth of Well	Elevation Top of River	Elevation Invert of Outfall	Pipe Length - Feet	Bottom Elevation
30	85 + 06	1801.5	89.4	1697.15	1680.15	20.18	1680.15
31	84 + 06	1807.5	47.0	1697.01	1680.01	20.10	1680.10
32	83 + 06	1817.4	106.9	1697.16	1680.06	20.21	1680.21
33	82 + 06	1818.9	98.6	1696.93	1680.03	15.90	1680.03
34	81 + 13	1822.8	86.6	1696.82	1680.02	21.06	1680.02
35	80 + 06	1827.0	47.9	1697.66	1680.06	21.38	1680.06
36	79 + 02	1831.5	81.1	1697.25	1680.05	21.45	1680.05
37	78 + 16	1835.3	46.9	1697.00	1680.10	21.19	1680.10
38	77 + 06	1840.6	61.0	1696.93	1680.13	21.11	1680.13
39	76 + 06	1845.3	48.3	1697.28	1680.08	21.46	1680.08
40	75 + 06	1849.3	48.8	1697.17	1680.07	21.30	1680.07
41	74 + 04	1850.4	90.7	1697.13	1680.03	21.26	1680.03
42	73 + 10	1858.8	48.6	1697.39	1680.09	21.32	1680.09
43	72 + 14	1817.8	51.8	1697.12	1680.12	21.23	1680.12
44	71 + 13	1860.8	82.1	1697.10	1680.30	24.00	1680.30
45	70 + 10	1868.9	44.1	1697.61	1679.30	18.26	1679.30
46	69 + 10	1869.4	48.8	1697.89	1680.00	18.25	1680.00
47	68 + 10	1870.7	46.1	1697.18	1679.18	18.25	1679.18
48	67 + 10	1871.7	87.3	1697.77	1679.57	18.25	1679.57
49	66 + 10	1878.0	36.5	1698.29	1680.29	18.25	1680.29
50	65 + 10	1873.0	79.4	1697.12	1680.12	18.25	1680.12
51	64 + 10	1874.7	80.3	1697.02	1680.02	18.25	1680.02
52	63 + 10	1875.8	38.5	1698.80	1680.80	18.25	1680.80
53	62 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
54	61 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
55	60 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
56	59 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
57	58 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
58	57 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
59	56 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
60	55 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
61	54 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
62	53 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
63	52 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
64	51 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78
65	50 + 10	1876.8	38.5	1697.78	1679.78	18.25	1679.78

\* Relief Well located in marsh.

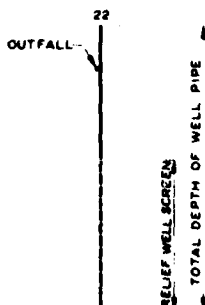


**GENERALIZED GEOLOGIC PROFILE**  
(CONDITIONS BETWEEN BORINGS ESTIMATED ONLY)  
SCALE VERT 1" = 20'  
HORIZ 1" = 200'

Station	Depth of Well	Elevation		Pipe Lengths - Feet			Bottom Elevation
		Top of River	Invert of Outfall	Riser Pipe	Blank Pipe	Total Screen	
06 1203.9'	89.4	1697.15	1680.15	20.18	5.00	64.15	1607.8
06 1207.7	87.0	1697.01	1680.01	20.10	4.66	22.26	1690.0
06 1217.4	86.9	1697.16	1680.06	20.21	4.95	81.83	1590.3
06 1218.9	86.6	1696.93	1680.03	15.90	4.65	10.92	1698.3
13 1222.8	85.6	1696.82	1680.02	23.06	35.20	28.47	1610.2
06 1227.0	87.2	1697.66	1680.06	23.22	4.65	19.35	1649.8
06 1231.9	84.1	1697.25	1680.05	23.45	4.65	92.36	1612.2
16 1235.7	86.9	1697.00	1680.10	23.19	4.65	19.10	1690.1
06 1240.8	81.0	1696.93	1680.13	23.11	4.66	33.27	1635.0
06 1245.3	88.3	1697.28	1680.08	23.46	4.65	20.21	1649.0
06 1250.7	82.8	1697.17	1680.07	23.30	4.65	18.68	1654.4
04 1260.4	90.7	1697.13	1680.03	23.26	4.63	22.61	1646.1
10 1268.8	86.6	1697.39	1680.09	23.32	4.65	20.45	1648.8
14 1317.8	51.2	1697.12	1680.12	23.23	4.65	23.25	1645.9
23 1360.8	82.1	1697.10	1680.30	24.00	32.99	25.89	1615.0
40 1368.3	44.4	1691.61	1679.30	18.26	4.67	21.97	1647.2
40 1369.4	46.8	1691.89	1680.00	18.25	5.00	23.19	1645.1
40 1370.9	46.1	1691.18	1679.18	18.25	4.65	23.51	1645.7
40 1371.7	87.3	1691.57	1679.57	18.25	29.88	39.66	1604.3
40 1372.6	36.5	1692.29	1680.29	18.25	4.63	13.68	1655.8
40 1373.6	37.3	1692.12	1680.12	18.26	4.67	14.63	1654.6
40 1374.7	36.5	1691.02	1678.02	18.34	5.01	27.24	1640.3
40 1375.8	36.6	1692.20	1680.20	18.30	4.60	13.70	1655.6
40 1376.8	38.5	1691.78	1679.78	18.26	4.64	9.71	1659.3
45 1385.0'	39.6			4.67	30.51	24.46	1656.9

## LEGEND

- ▲ SYMBOL FOR RELIEF WELLS  
14 RELIEF WELL NUMBER



THIS DRAWING HAS BEEN REDUCED TO  
THREE-EIGHTHS THE ORIGINAL SCALE.

DATE	DESCRIPTION	SCALE	APPROVED
DIVISION			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
MISSOURI RIVER			
GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES RELIEF WELLS PLAN AND PROFILE			
DESIGNED BY: S.S.A.	CHECKED BY: S.S.A.	DATE: MAY 1984	
DESIGNED BY: S.S.A.	CHECKED BY: S.S.A.		
APPROVED BY: <i>Charles E. Blagg</i>		DATE: MAY 1984	
APPROVED BY: <i>Donald J. DeClaw</i>		DATE: MAY 1984	

SCALE 1-5

SCALE 1-10

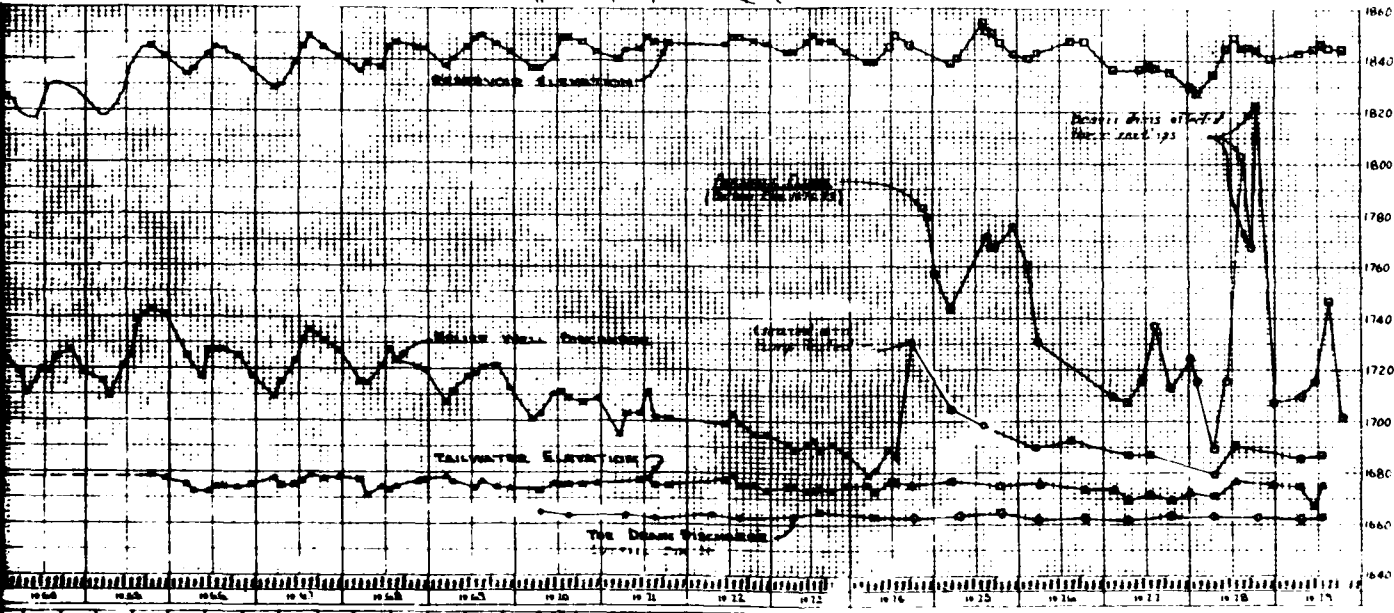
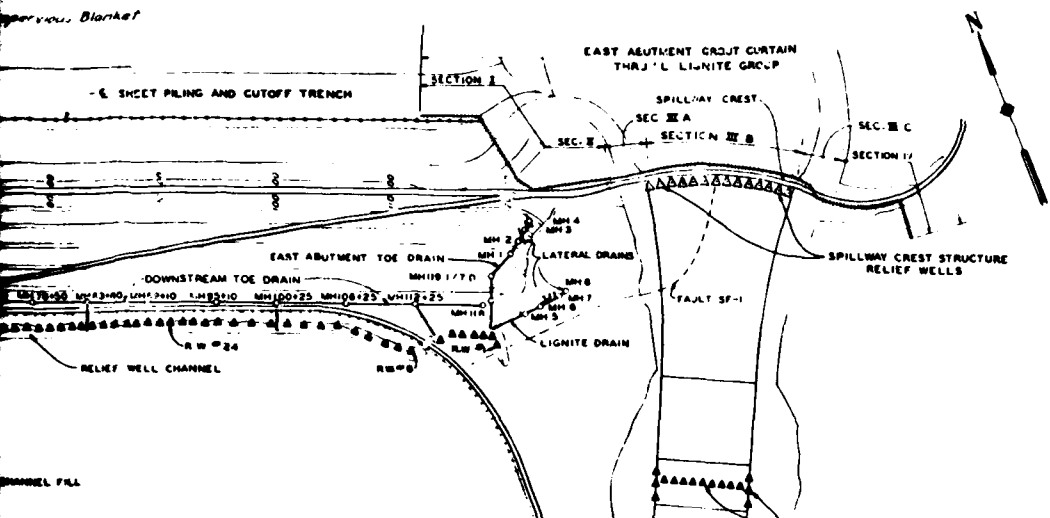
SCALE 5-4-3-2-1

Flange on all cast iron fittings may be removed if additional clearance is desired for pipe used for gravel pushing.









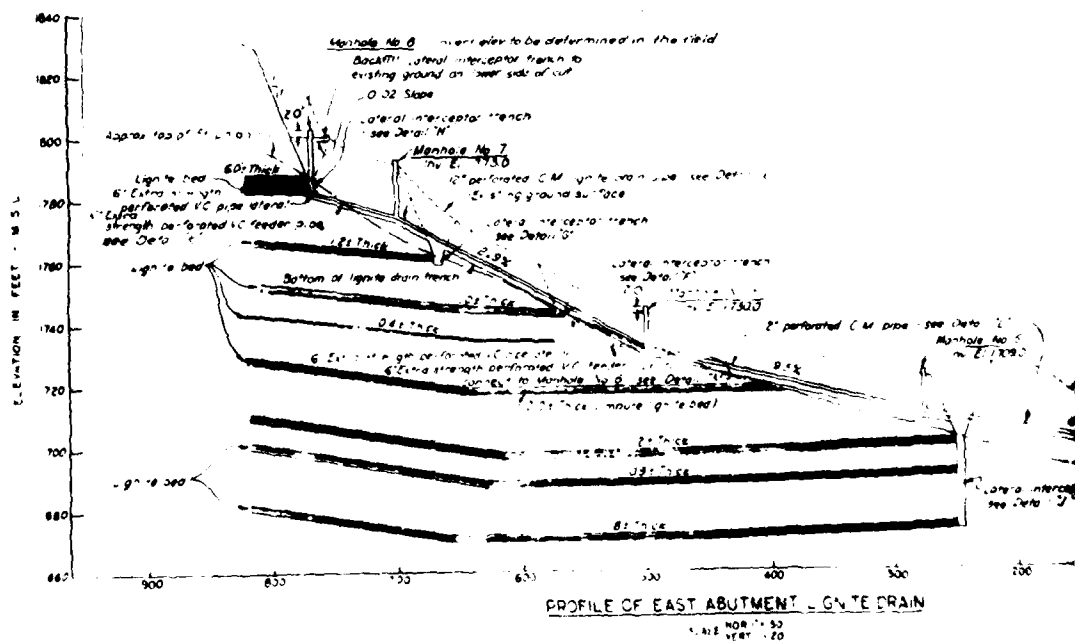
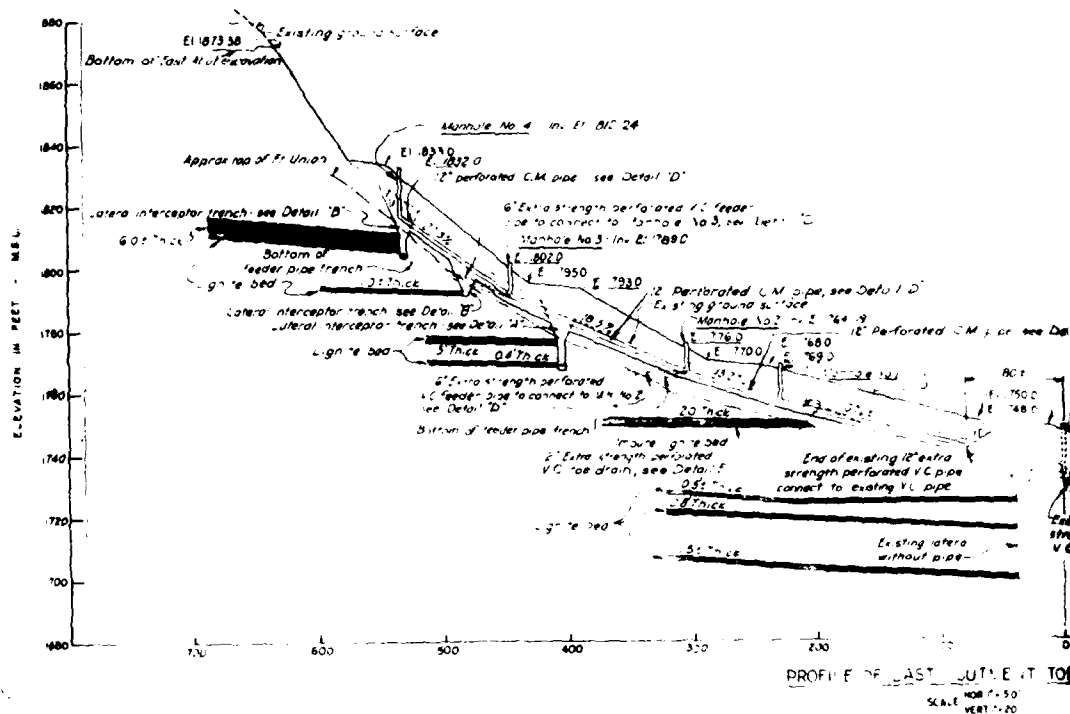
DATE	TIME	RELIEF WELL DISCHARGE (GPM)	TAILWATER ELEVATION (FEET)	THE DRAIN DISCHARGE (GPM)
1958				
1959				
1960				
1961				
1962				
1963				
1964				
1965				
1966				
1967				
1968				
1969				
1970				

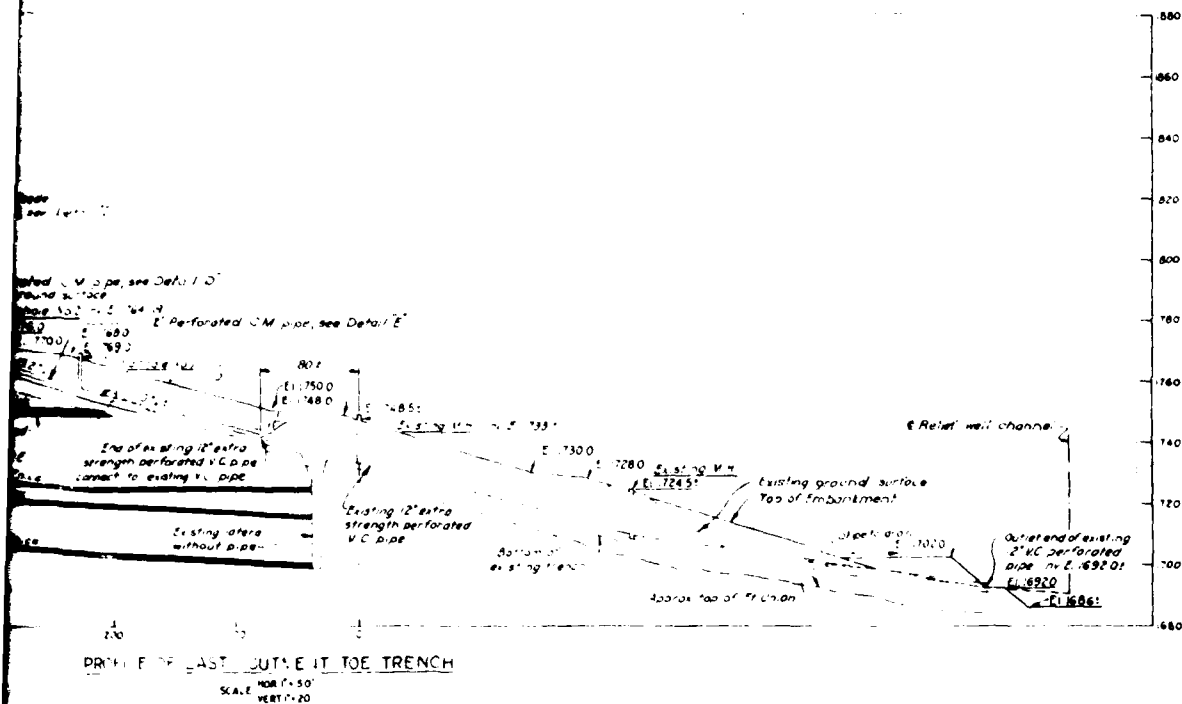
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA	
MISSOURI RIVER GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES DOWNSTREAM TOE RELIEF WELLS AND TOE DRAIN DISCHARGE	
DESIGNED BY:	DATE:
DRAWN BY:	CHECKED BY:
REVIEWED BY:	APPROVED BY:
DATE:	DATE:
DATE:	DATE:





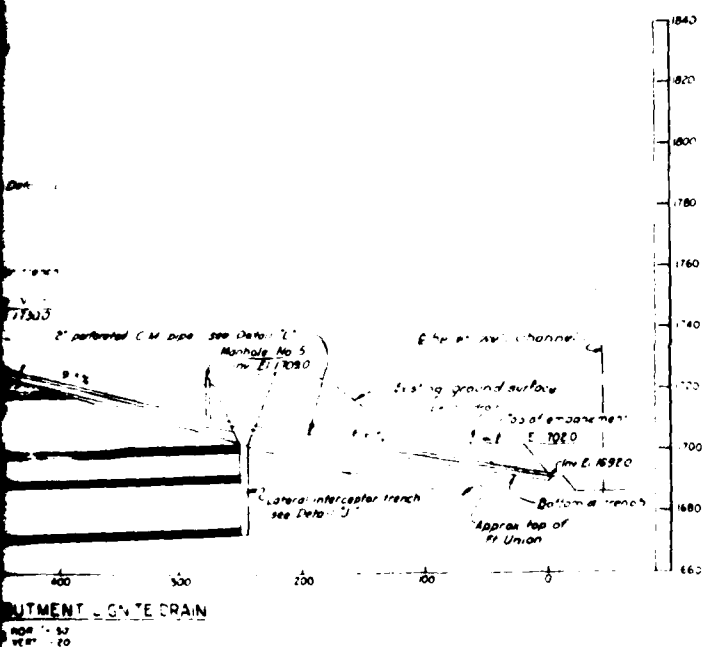






#### NOTE

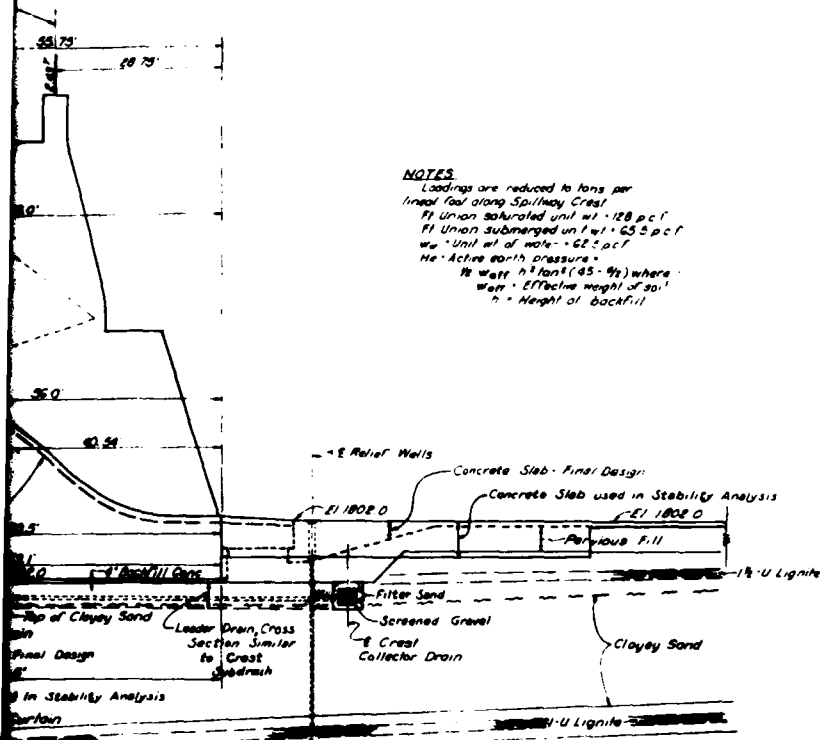
PROFILES FOR THIS PLATE TAKEN FROM STAGE IV CONTRACT, DRAWING GE10-8/11



DATE		REVISION		DRAWN	
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA					
GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES TOE AND LIGNITE DRAINS EAST ABUTMENT PROFILES					
DESIGNED BY	C. S. S.	APPROVED BY	C. S. S.	DATE	11/11/82
DRAWN BY	C. S. S.	APPROVED BY	C. S. S.	DATE	11/11/82
CHECKED BY	C. S. S.	APPROVED BY	C. S. S.	DATE	11/11/82
SCALE: AS SHOWN					



Reinforced Concrete Bridge

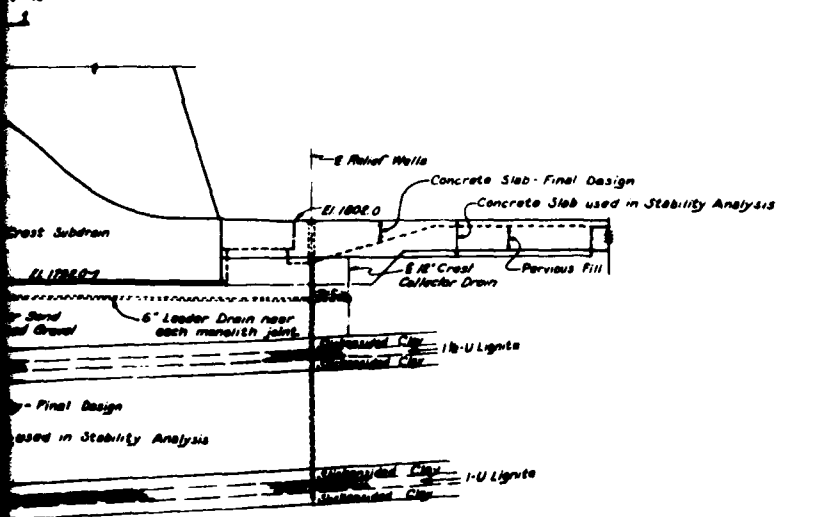


# NOTES

Loadings are reduced to tons per  
linear foot along Spillway Crest  
 $P_1$  - Unit on saturated unit wt. = 128 p.c.f.  
 $P_2$  - Unit on submerged unit wt. = 63.5 p.c.f.  
 $w_w$  - Unit wt. of water = 62.4 p.c.f.  
 $H_a$  - Active earth pressure =  
 $\frac{1}{2} w_w h^2 \tan^2(45 - \frac{\phi}{2})$  where  
 $w_w$  = Effective weight of soil  
 $h$  = Height of backfill

SECTION - 140' E OF C

1:10



# GENERAL NOTES

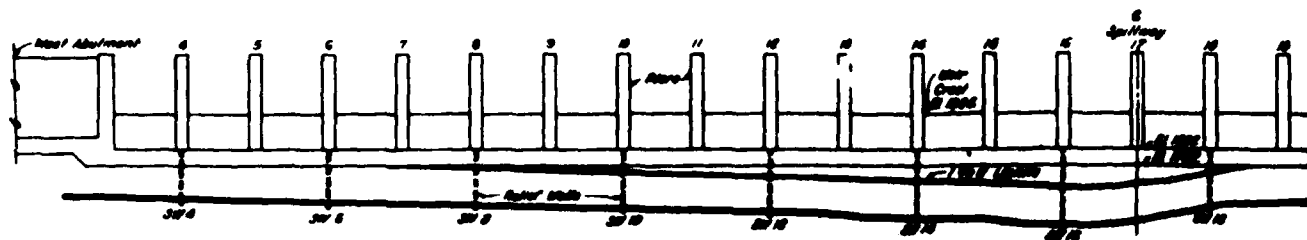
1. For flow net and uplift on failure see, See Day No. GSX-5/37
2. Crest structure loading used for Stability Analysis shown in Fig. 1, final design section differs slightly. See Plate Nos. III & IV.

SECTION - 20' E OF C

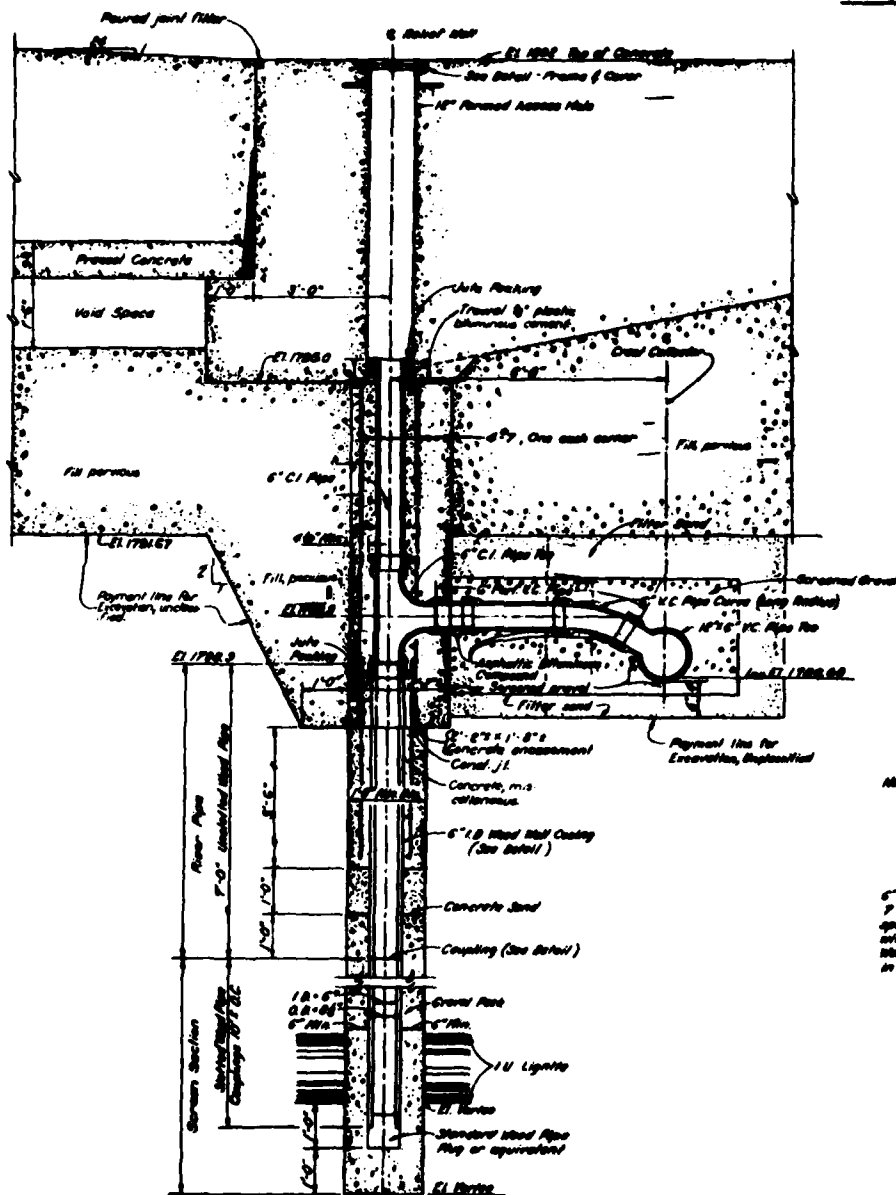
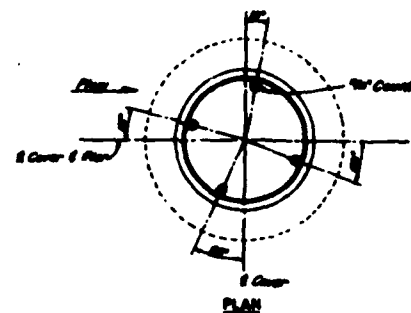


DESIGNED BY		CHECKED BY	
DATE		DATE	
<p>U. S. ARMY          CORPS OF ENGINEERS          OFFICE OF THE DISTRICT ENGINEER          MISSOURI RIVER</p> <p><b>GARRISON DAM AND RESERVOIR          SPILLWAY CREST STABILITY          GENERALIZED ANALYSIS SECTIONS</b></p>			
SCALE		SHEET NO.	
PROJECT NO.		DATE	
DRAWN BY		DATE	
CHECKED BY		DATE	
APPROVED BY		DATE	
PROJECT NO.		SHEET NO.	
DRAWN BY		DATE	
CHECKED BY		DATE	
APPROVED BY		DATE	

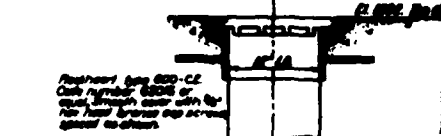
22



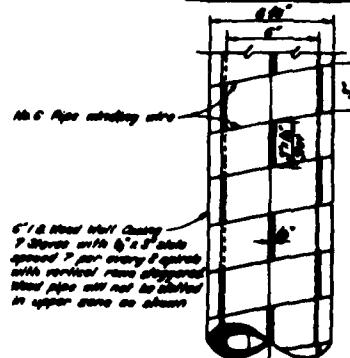
**PROFILE ALONG RELIEF WELLS LOOKING UPSTREAM**



### RELIEF WELL DETAILS



**SECTION**  
**DETAIL - FRAME & COVER**



**ELEVATION**

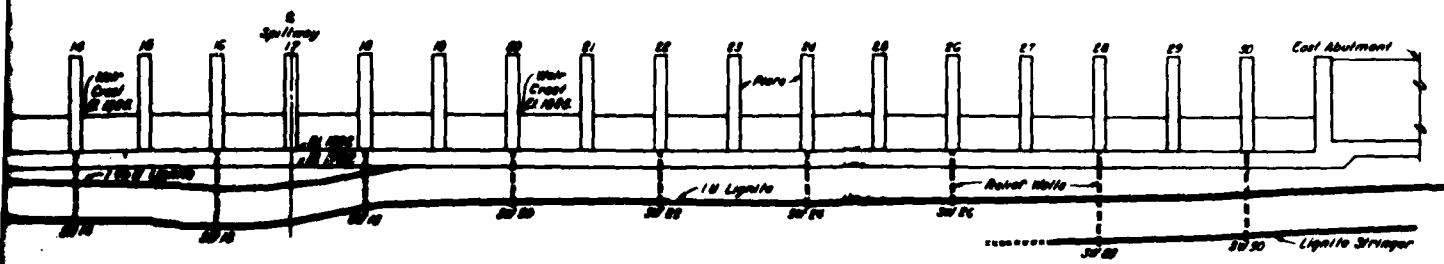


## SECTION

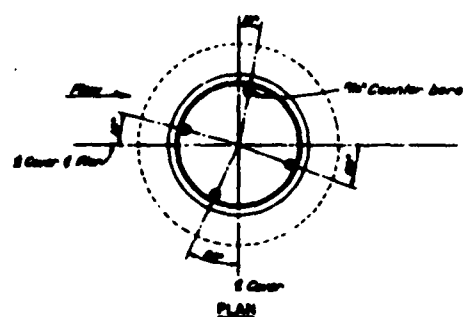
**DETAIL OF SLOTTED WOOD PIPE**



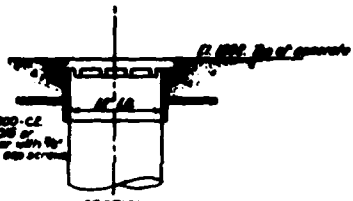




PROFILE ALONG RELIEF WELLS LOOKING UPSTREAM

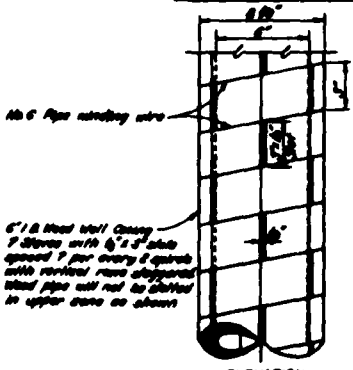


PLAN



SECTION  
DETAIL-FRAME & COVER

SCALE 1" = 20"



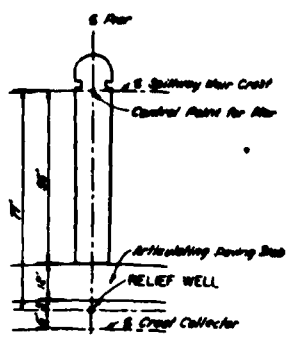
ELEVATION



SECTION

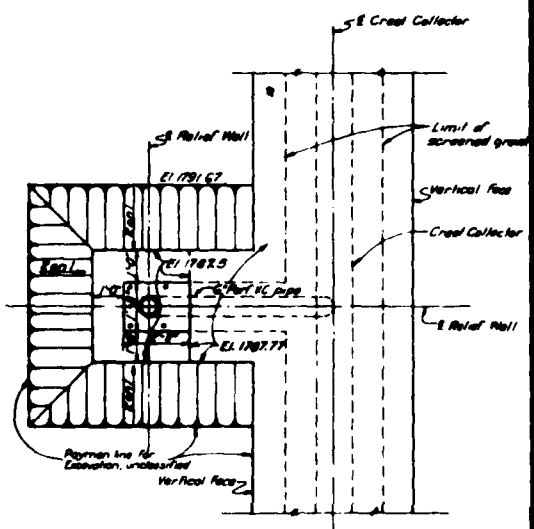
DETAIL OF SLOTTED WOOD PIPE

SCALE 1" = 20"



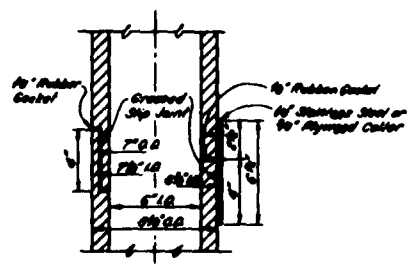
TYPICAL LOCATION  
OF RELIEF WELL

SCALE 1" = 20"



EXCAVATION PLAN  
RELIEF WELL PIT

SCALE 1" = 20"



INSERTED JOINT  
COUPLING

ALTERNATE DETAIL  
COLLAR COUPLING

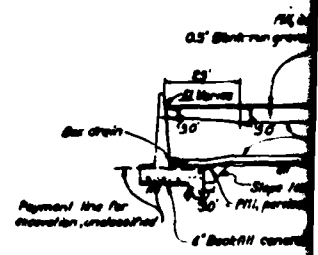
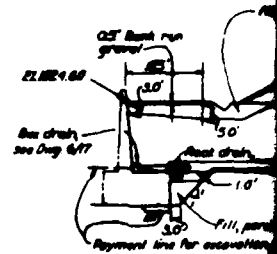
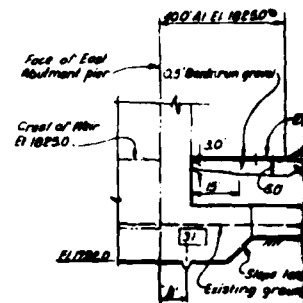
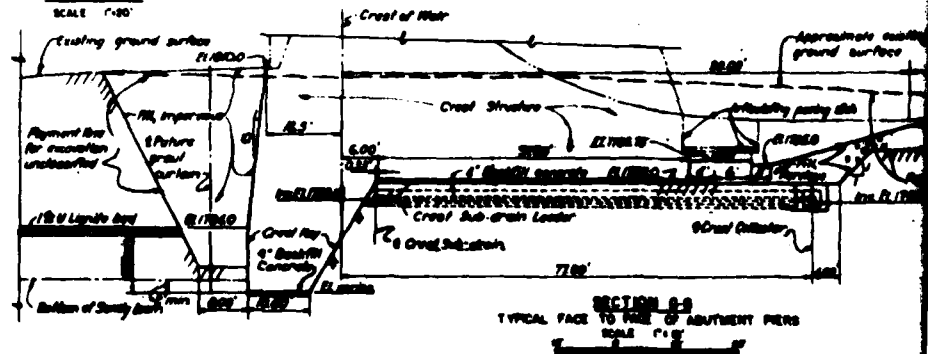
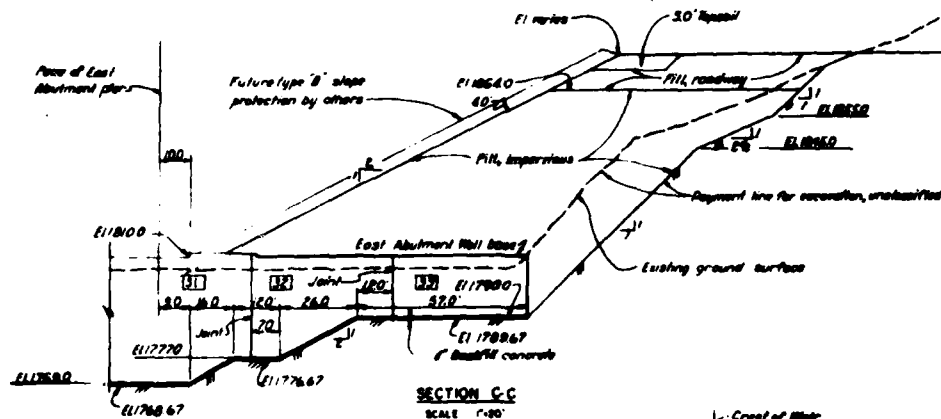
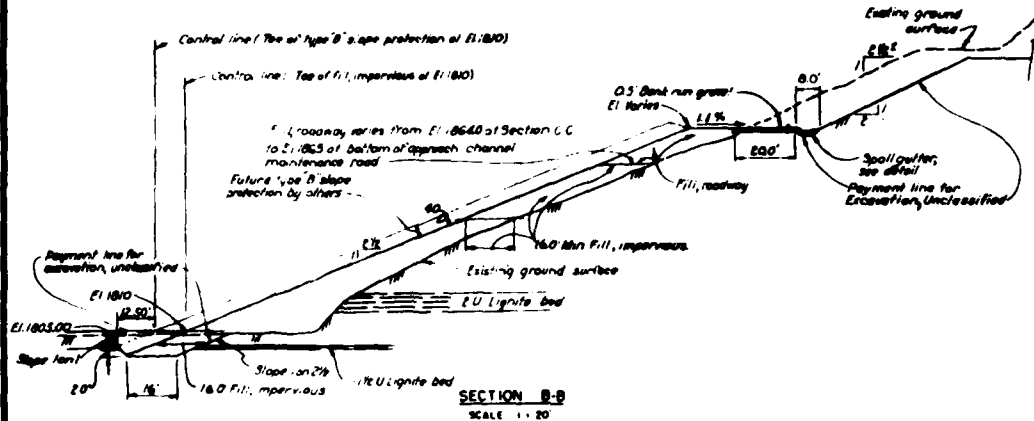
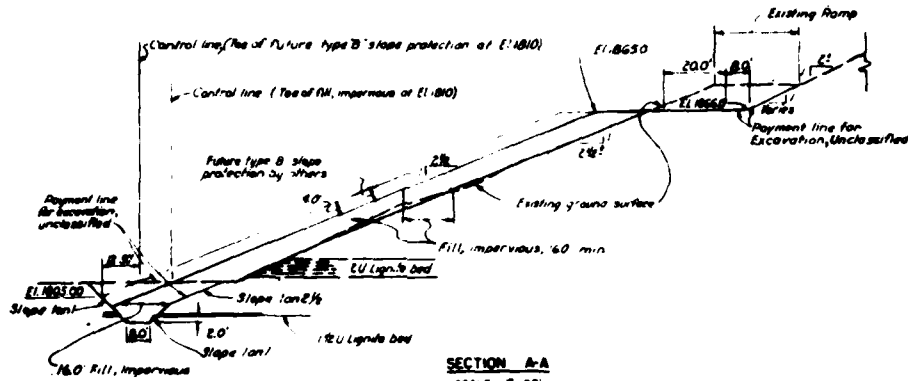
DETAIL OF COUPLING

SCALE 1" = 20"

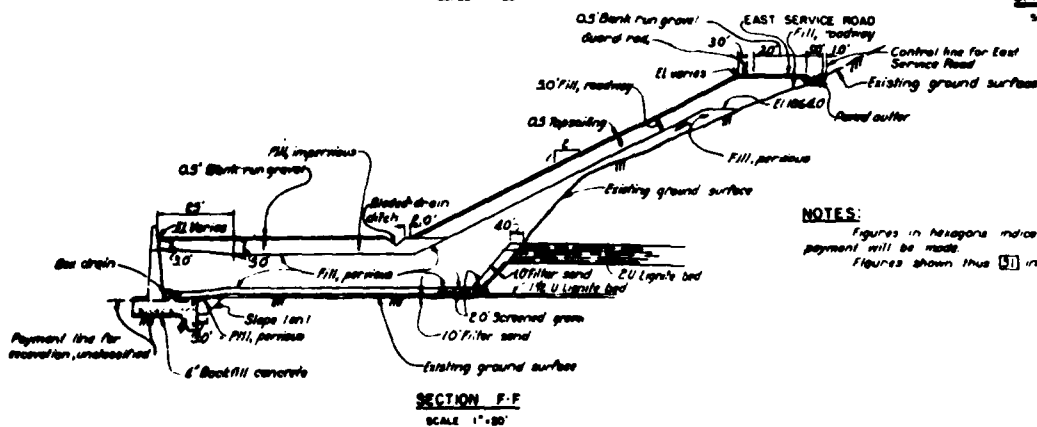
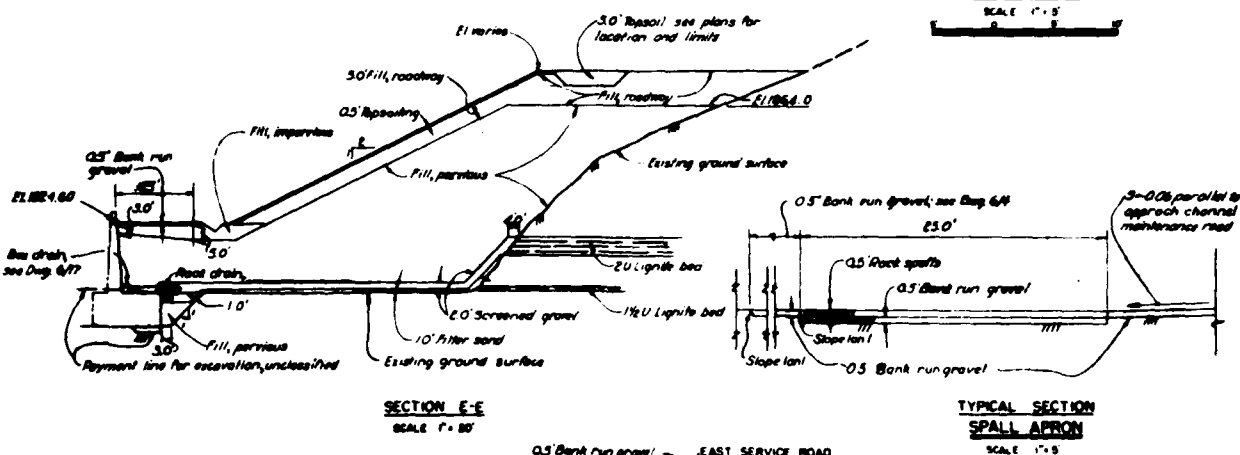
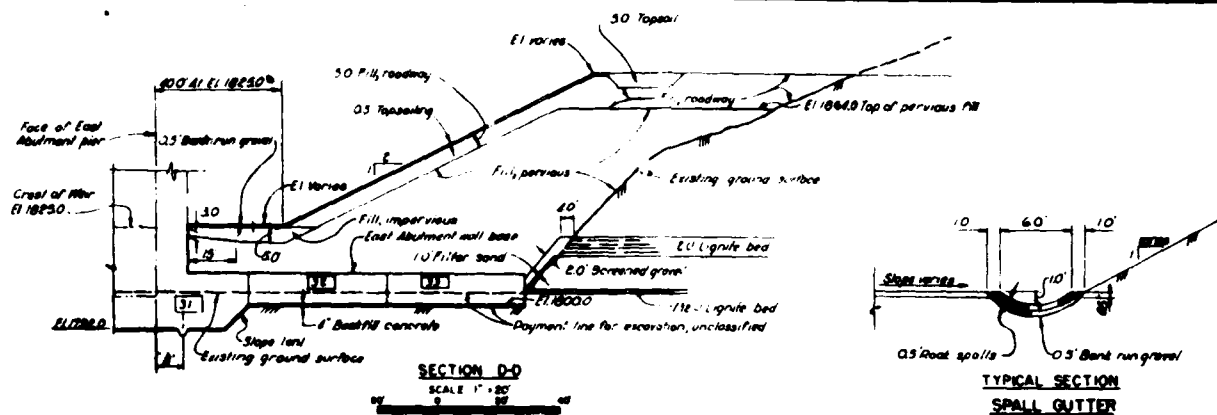
NOTES

Position of lignites on profile estimated between borings  
Exact depth of wells to be determined in field dependent on  
lignites as encountered

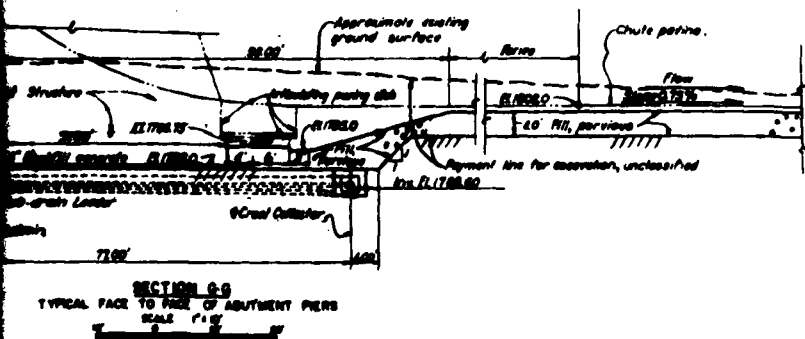
U. S. ARMY ENGINEER DISTRICT OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY STRUCTURES DRAINAGE RELIEF WELLS	
DATE MARCH 1932	BY 651-678



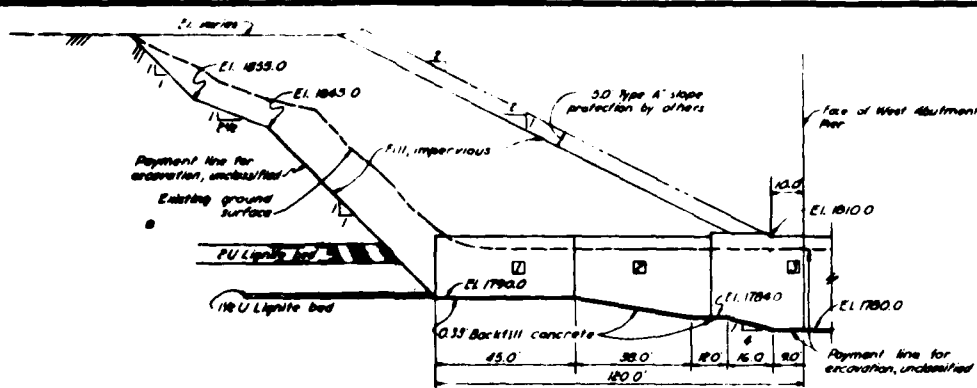
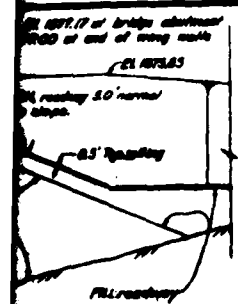
TYPICAL FACE TO FACE OF ABUTMENT PIERS  
SCALE 1" = 20'



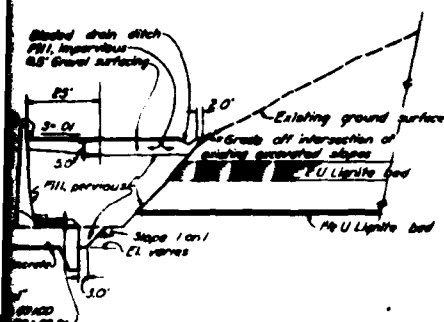
**NOTES:**  
 Figures in hexagons indicate item numbers under which payment will be made.  
 Figures shown thus **51** indicate Fast Abatement months.



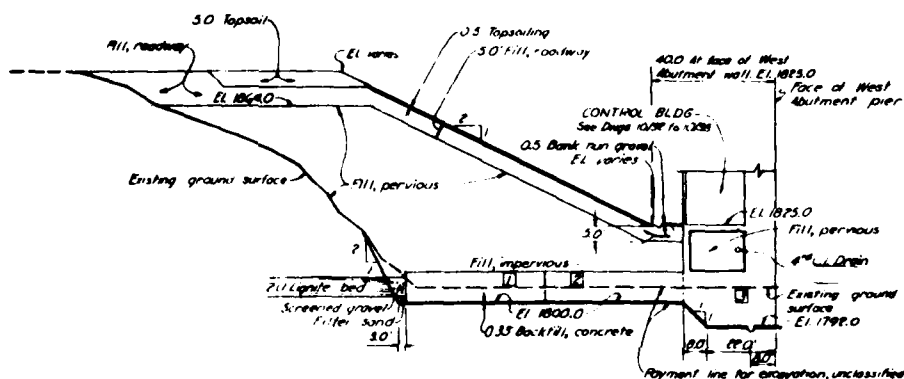




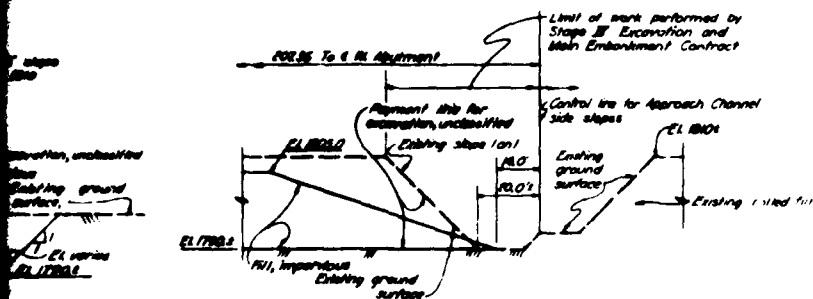
SECTION R-R  
SCALE 1" = 80'



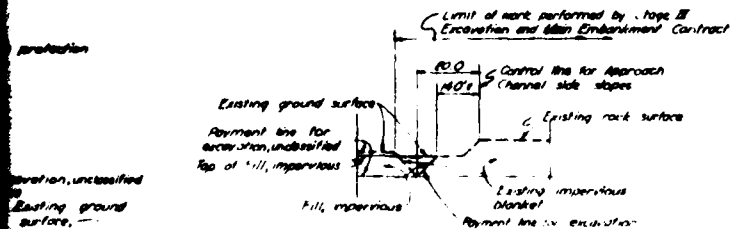
SECTION K-K  
SCALE 1" = 80'



SECTION S-S  
SCALE 1" = 80'



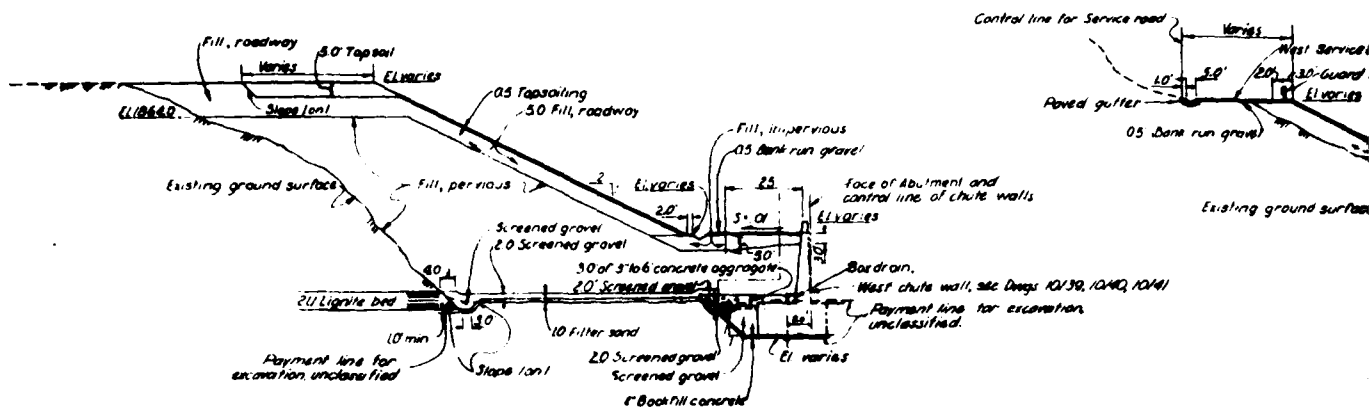
SECTION N-N  
SCALE 1" = 80'



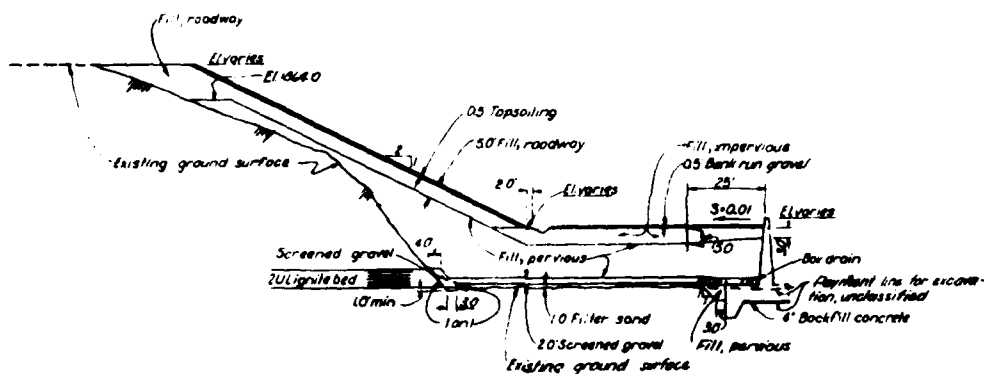
SECTION P-P  
SCALE 1" = 20'

NOTES  
Figures in parentheses indicate item numbers under  
which payment will be made.  
Figures shown thus [2] indicate number of first  
structure shown.

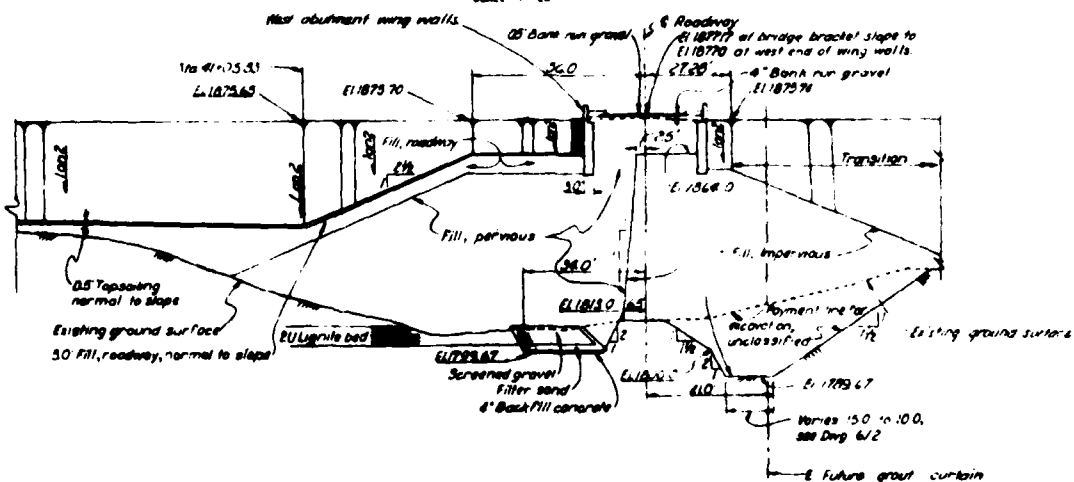
REV	DATE	REVISION
U.S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MINNEAPOLIS, MINN.		
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY STRUCTURES AND GATES EXCAVATION AND BACKFILL SECTIONS S4117.2		
DESIGNED BY 3/28/52 J. H. HARRIS	APPROVED BY 3/28/52 J. H. HARRIS	MAILED 3/28/52 1952



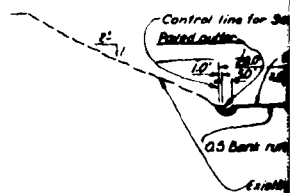
SECTION T-T  
SCALE 1"=20'



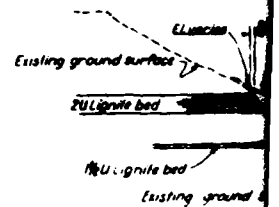
SECTION U-U  
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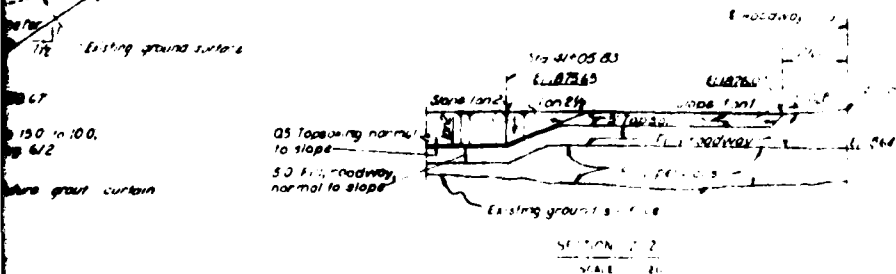
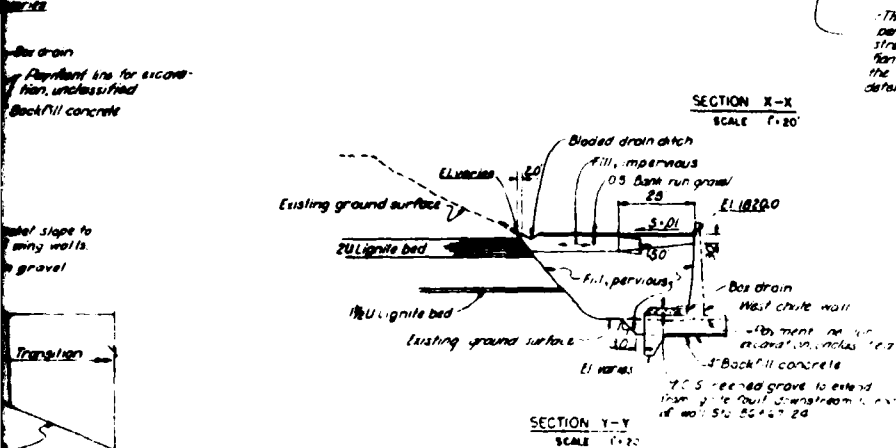
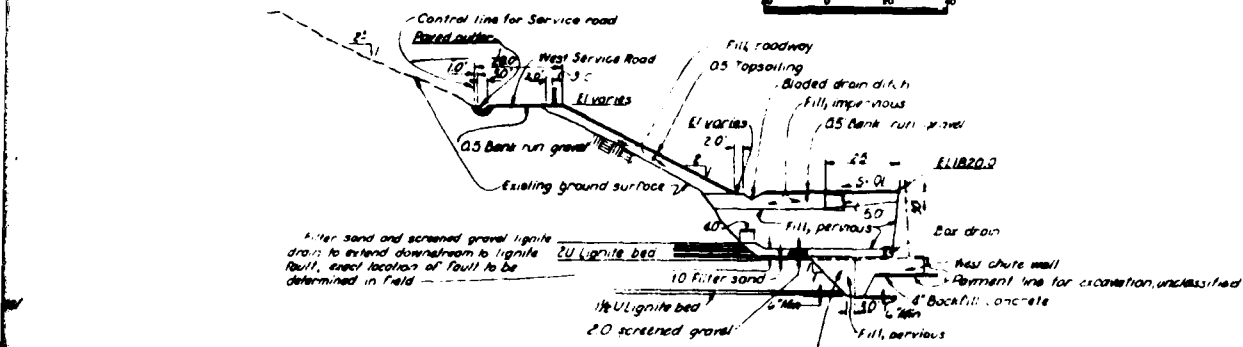
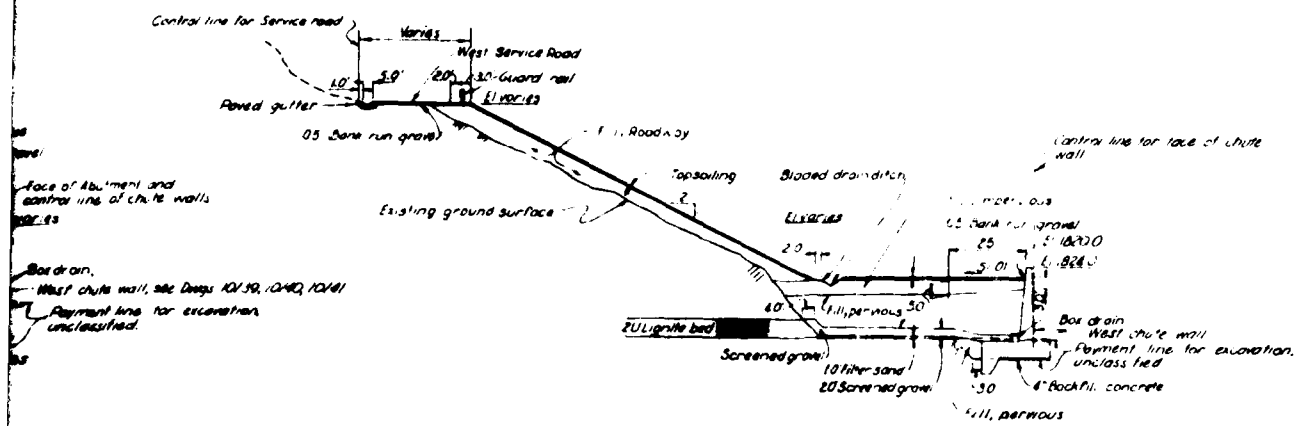
SECTION V-V  
SCALE 1"=20'



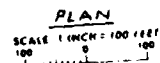
Filter sand and screened gravel layer drain to extend downstream to lignite bluff, exact location of bluff to be determined in field



0.5' Topsoil normal to slope  
5.0' Fill roadway normal to slope



U.S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DESIGN NO. 1	
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY STRUCTURE AND GATES EXCAVATION AND BACKFILL SECTION PLANET	
REPORT NO. 115	DATE 1952
DESIGNED BY [Signature]	CHECKED BY [Signature]
DRAWN BY [Signature]	APPROVED BY [Signature]
PROJECT NO. 115	SECTION NO. 115

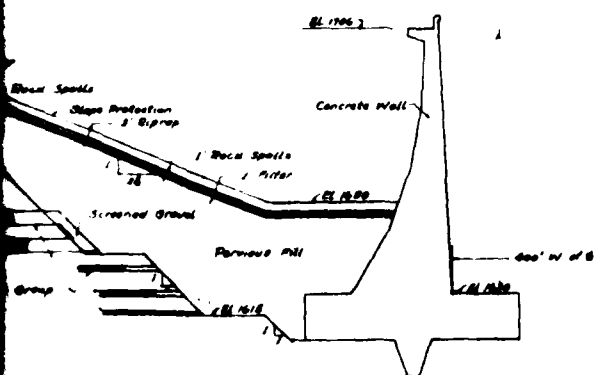
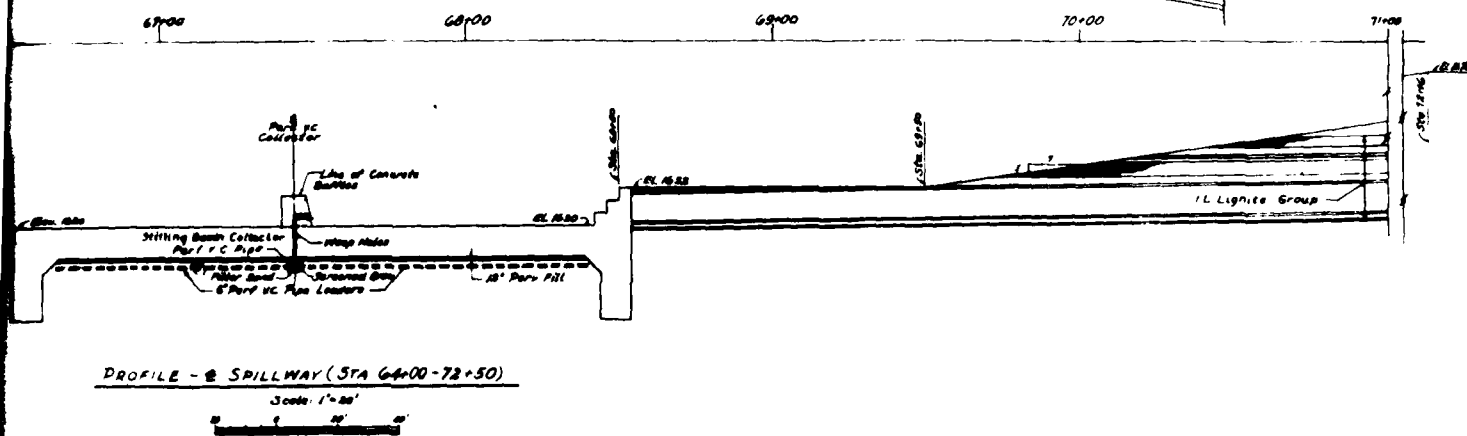
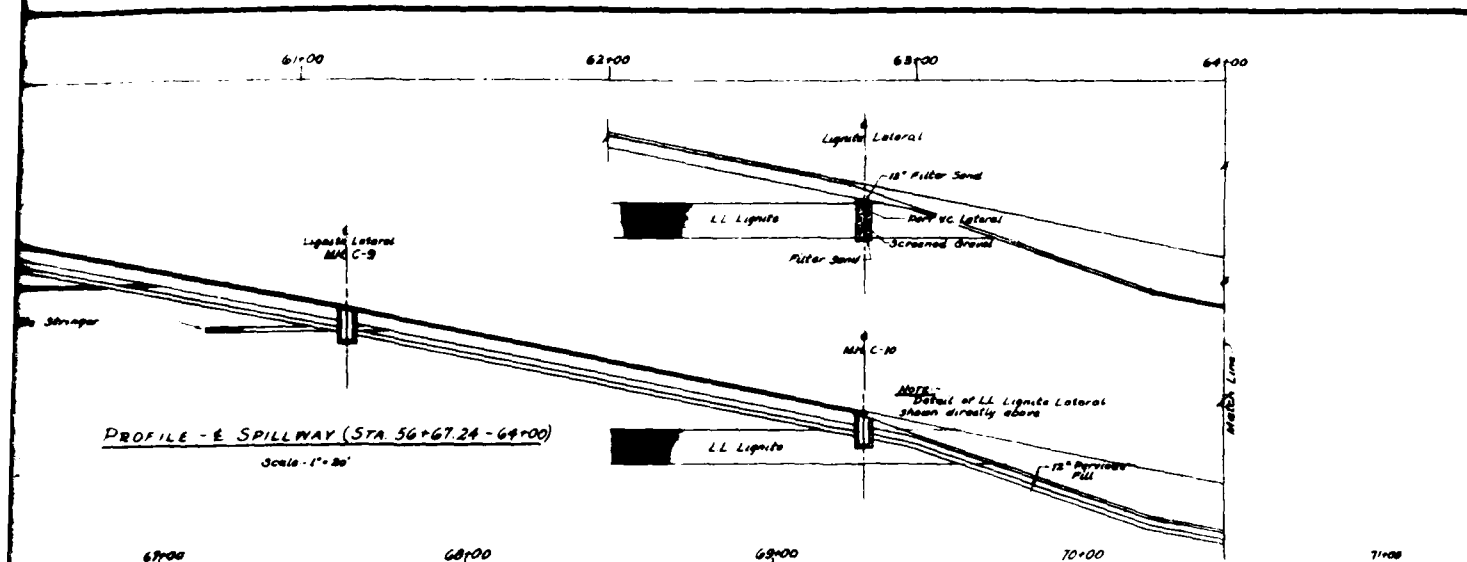


SPILLWAY DRAINAGE OBSERVATIONS									
	DATE	1-27-76	4-23-75	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW
MH #2	SMALL FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW
MH #8	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW
MH #6	SMALL FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW
MH #12	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW
MH E7 East	205	FACED	PROBLEM	22	21	NET	POD	3.4	3.75
North	46			330	3.0E				
West	DRY			DRY	DRY	DRY	LAMP	DRY	DRY
MH C7 East	DRY			DRY	DRY	DRY	DRY	DRY	DRY
North	5			508	4.6E	1.50	1.70	1.36	1.5
West	DRY			DRY	DRY	DRY	JUMP	DRY	DRY
MH W7 East	DRY			DRY	DRY	DRY	JUMP	DRY	DRY
North	75			408	3.97	75	3.0	4.1	3.75
West	167			0.1	0.18	DRY	DRY	DAT	DAMP
MH 15 w Outfall	NO FLOW			DRY	DRY	DRY	DRY	DRY	DRY
MH 18 w Outfall	NO FLOW			DRY	DRY	DRY	DRY	DRY	DRY

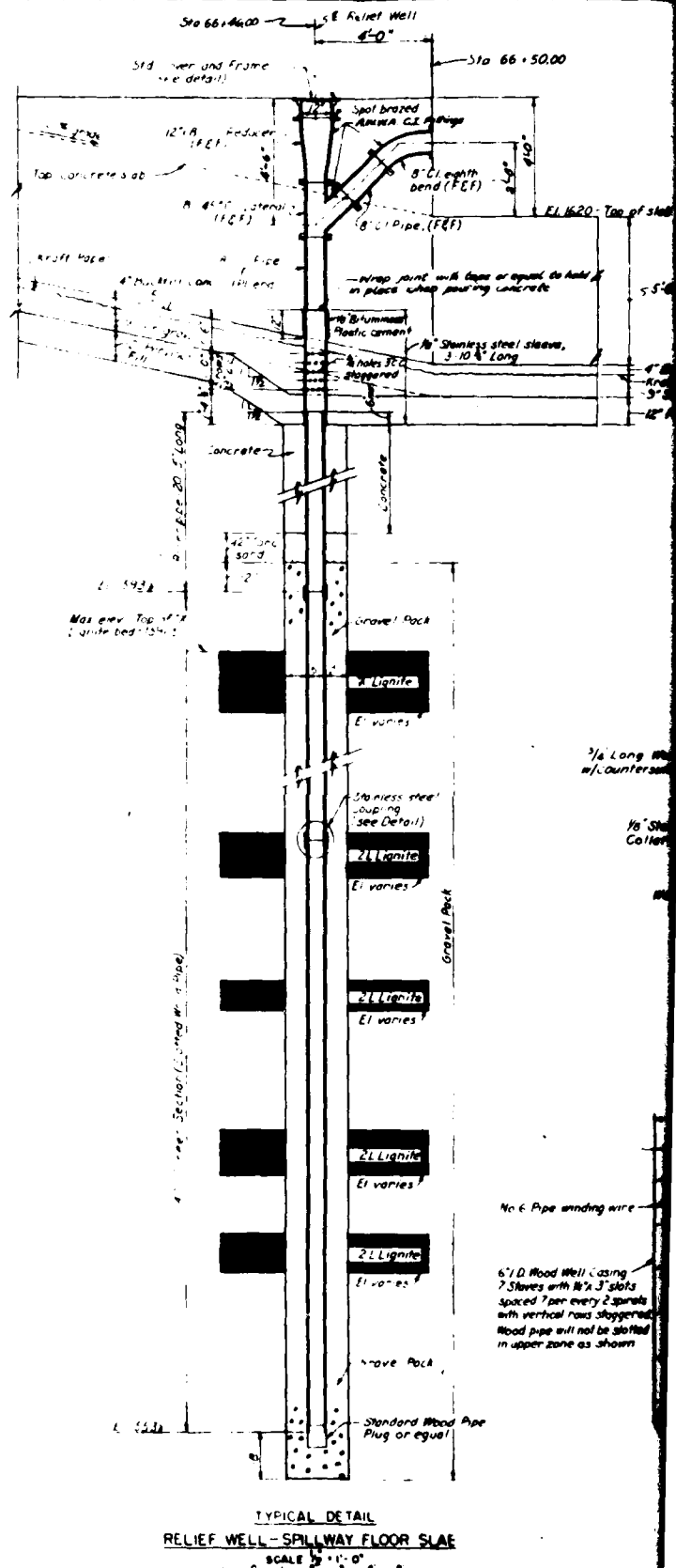
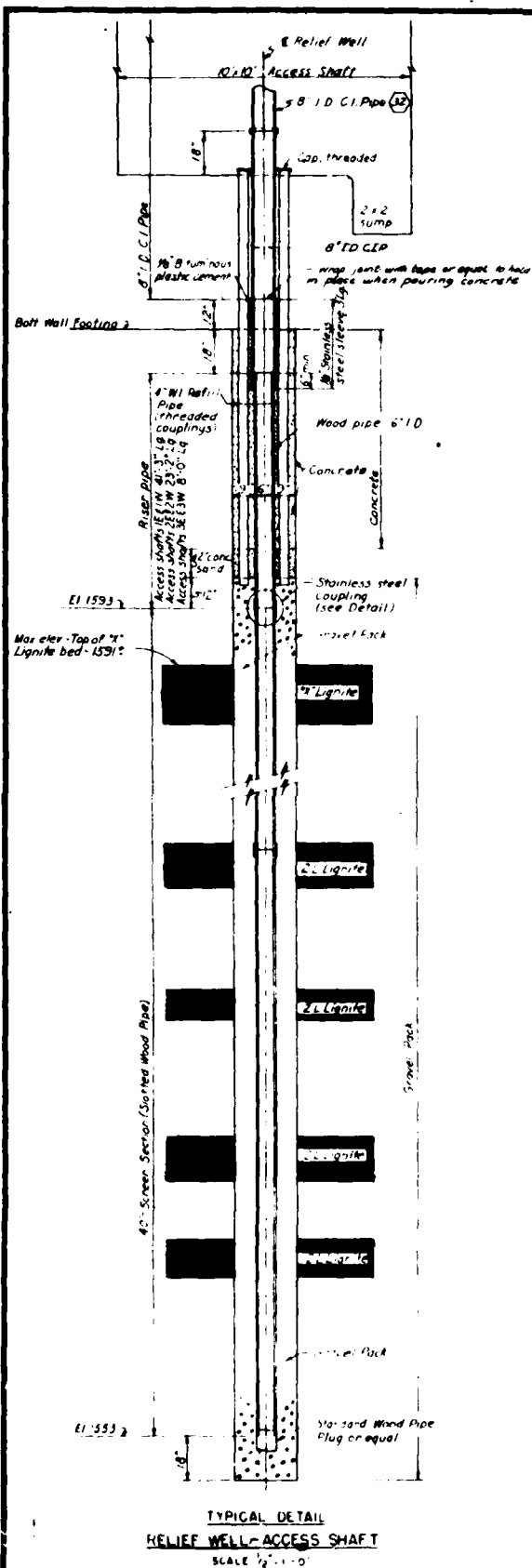




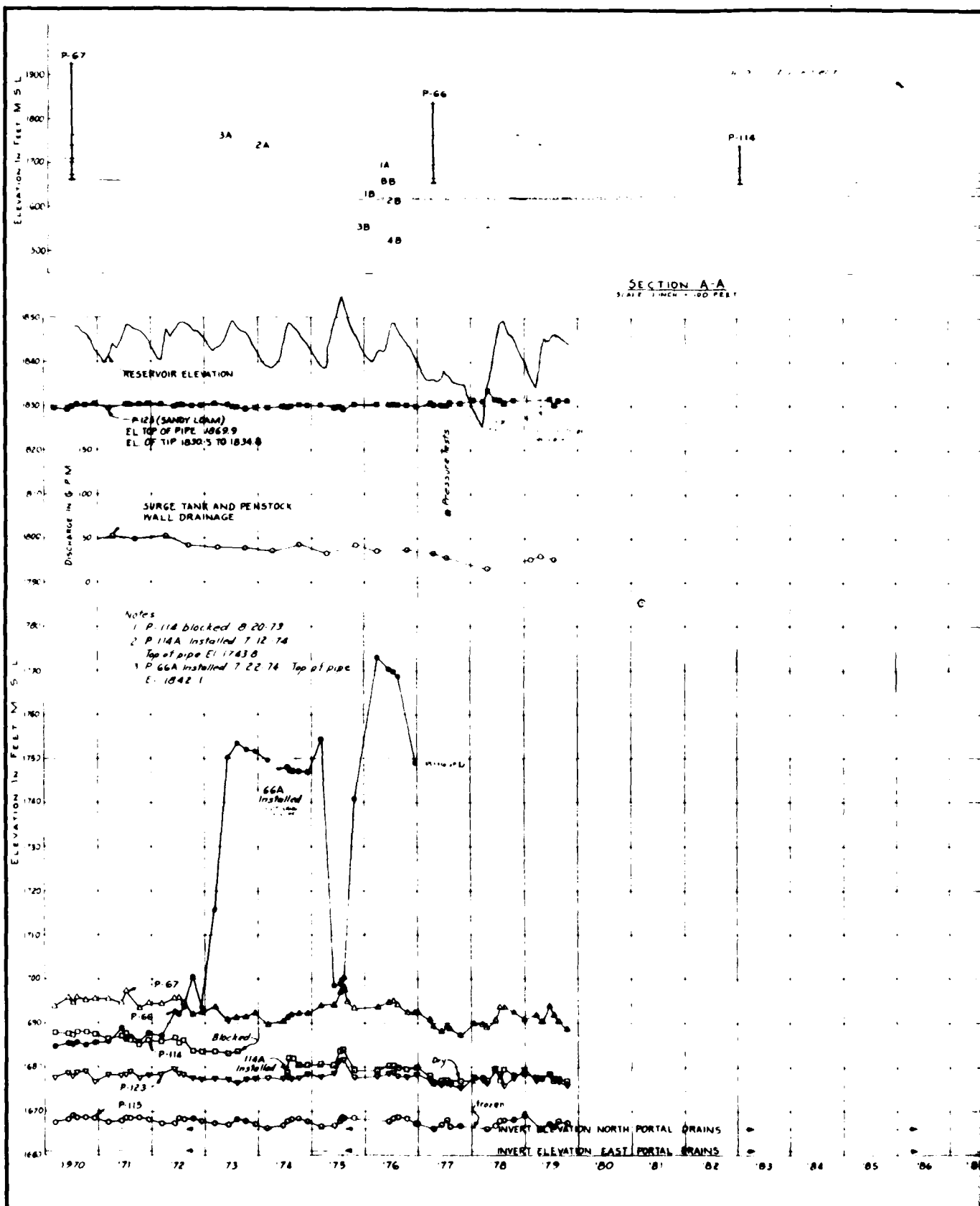




REV	DATE	REVISION	BY	CHKD	APPD
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER ST. LOUIS, MO.					
MISSOURI RIVER GARRISON DAM AND RESERVOIR SPILLWAY STILLING BASIN TENTATIVE DRAINAGE DETAILS					
MARCH 1952 GSX-3766					







P-114

P-115

P-123

BB 1A

2B 15

3B

4B

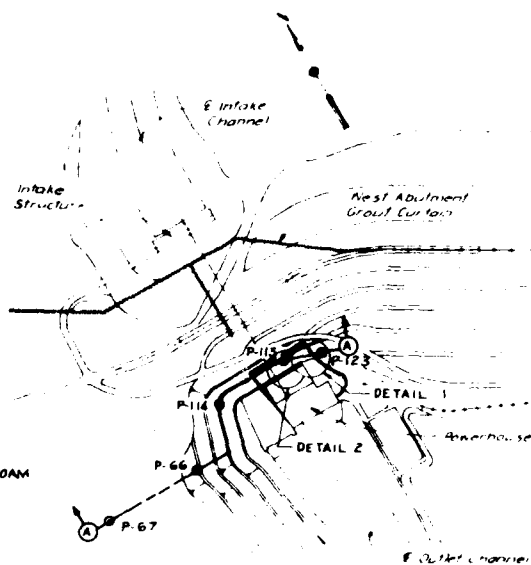
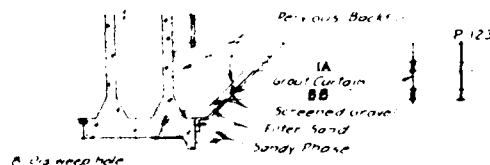
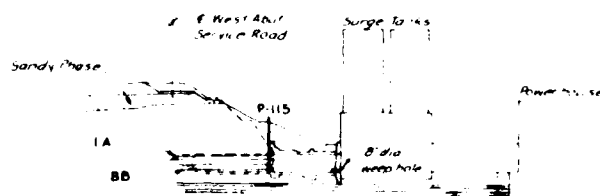
1900

1800

1700

1600

1500

KEY PLAN  
NO SCALEP-125  
● SANDY LOAMDETAIL 1  
SCALE 1 INCH = 40 FEETDETAIL 2  
SCALE 1 INCH = 40 FEET

Note:  
For data prior to 1970 see the following  
plates in the 1969 Periodic Inspection  
Report:  
Plate B 56 for P-114, P-115, P-123  
8 Well Discharge  
Plate B 58 for P-66 & P-67  
Plate B 62 for P-125

• Pressure tests were conducted  
in June 1971 and August 1971  
and all tests responded well.  
Piezometer P-125 is being  
replaced.

THIS DRAWING HAS BEEN REDUCED TO  
THREE-FIFTHS THE ORIGINAL SCALE

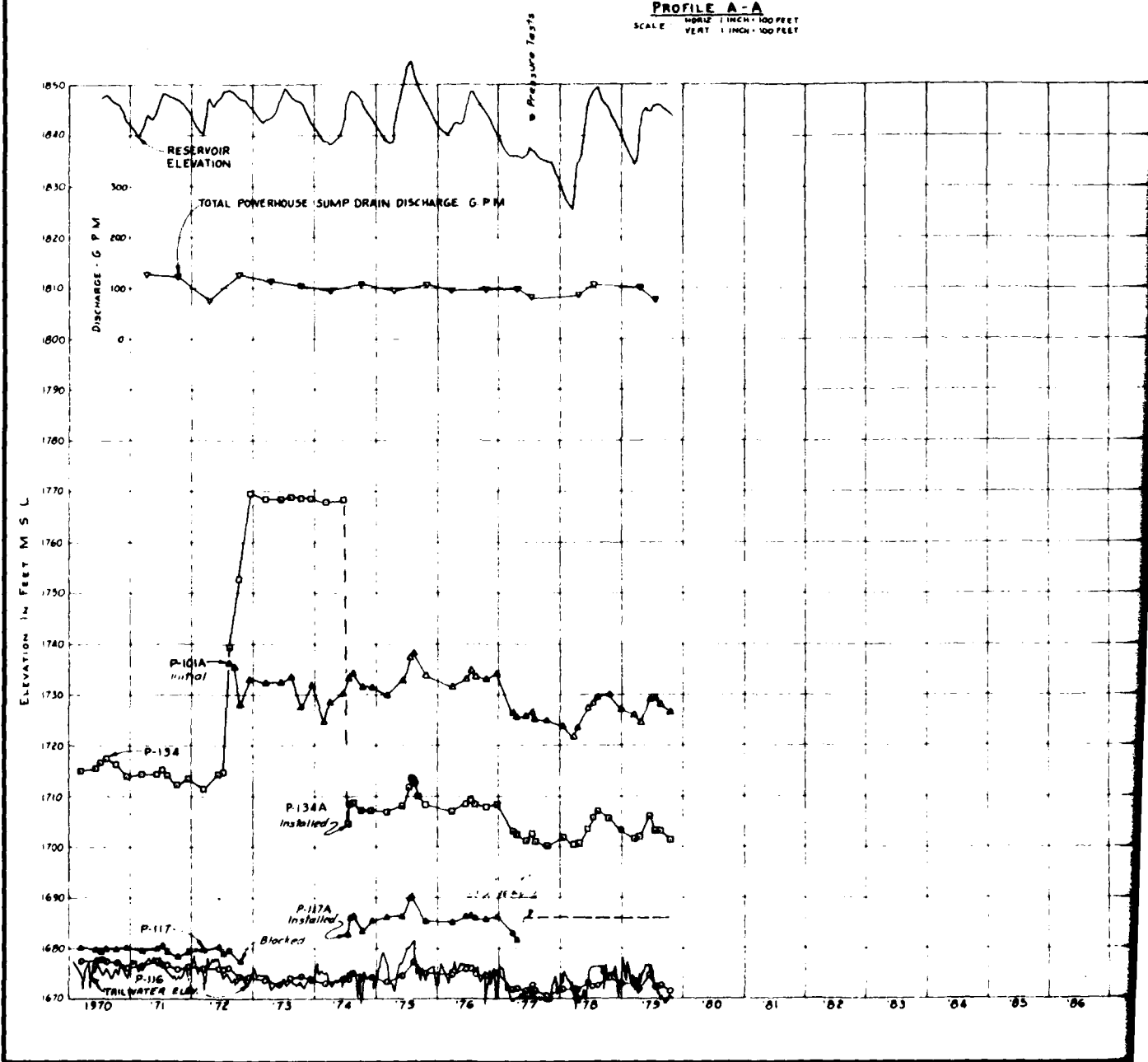
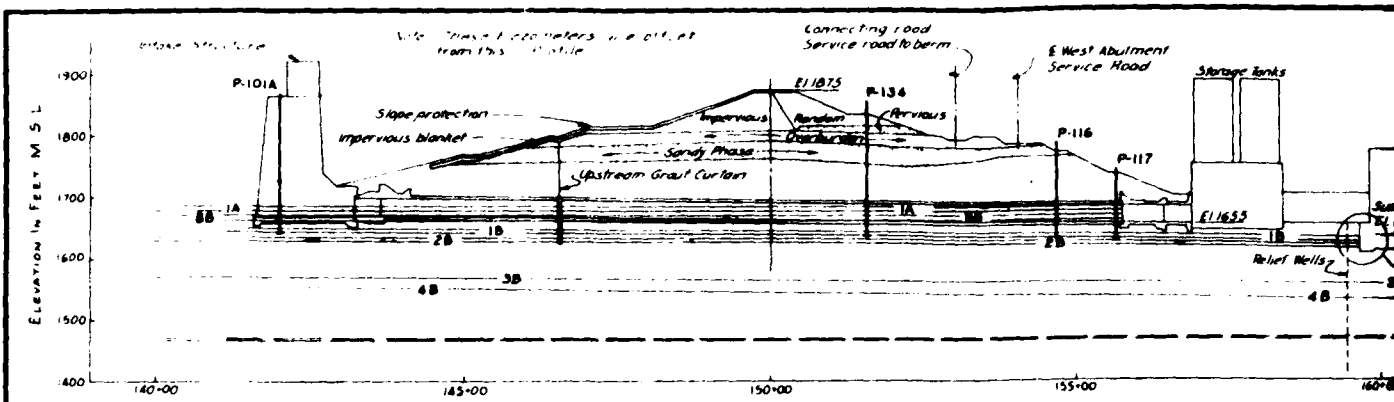
DATE	DESCRIPTION	MADE	APPROVED
REVISIONS			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
MISSOURI RIVER GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES WEST ABUTMENT PIEZOMETERS SANDY LOAM & 1A AND 2B LIGNITES SURGE TANK AND PENSTOCK WELL DRAINS			
DESIGNED BY	CHECKED BY	DATE	
DRAWN BY	APPROVED BY	DATE	
CHECKED BY	DATE	SCALE AS SHOWN	DATE
APPROVED BY	DATE	DATE	

THIS PLAN ACCOMPANIES CONTRACT NO.  
MODIFICATION NO.

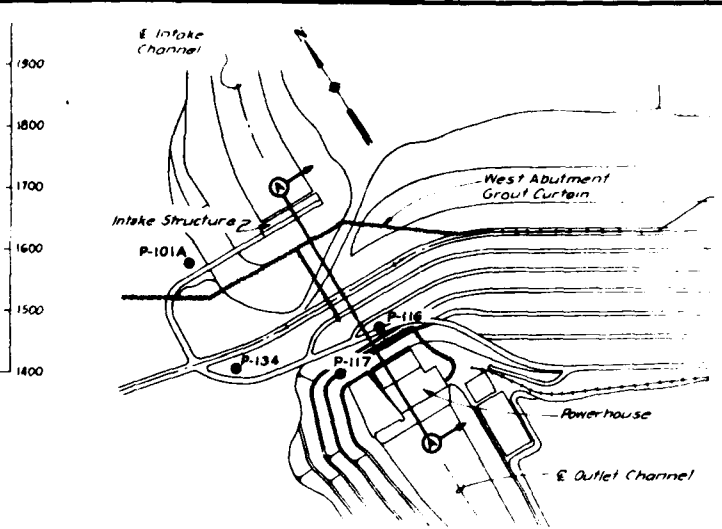
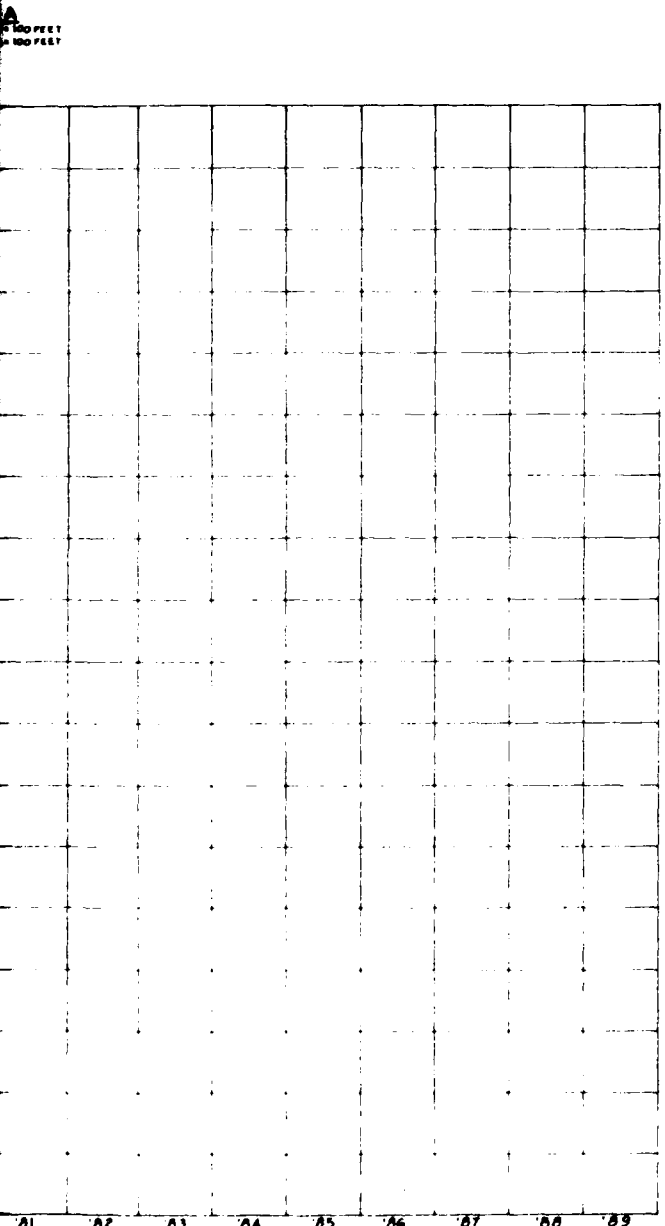
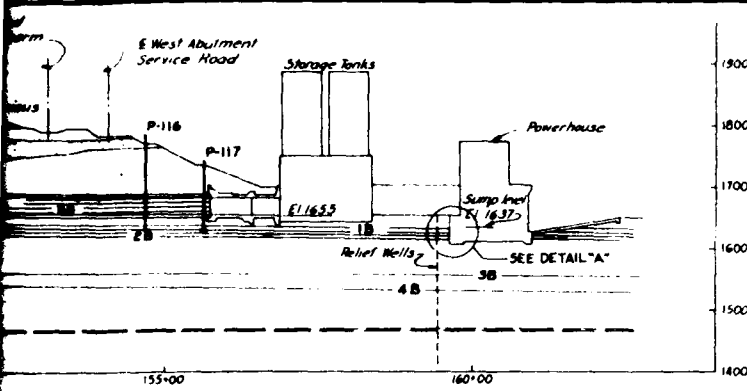
CONSTRUCTION FOUNDATION REPORT

(1982)

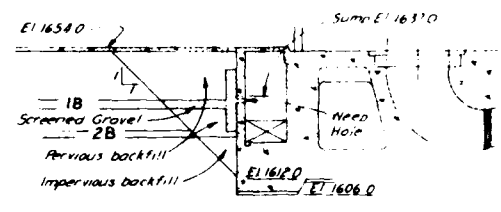
PLATE 119







**KEY PLAN**  
NO SCALE



**DETAIL "A"**  
SCALE 1 INCH = 20 FEET

• Pressure Tests were conducted in June, July and August 1977 and all piezometers responded well.

- Notes:**
1. P-101 Plugged 6-4-71
  2. P-101A initial reading 8-17-73
  3. P-117 Plugged 12-7-72
  4. P-117A installed 7-12-74 Top of pipe EL 1743.3
  5. P-134A installed 7-12-74 Top of pipe EL 1855.0

**Note:**  
For data prior to 1970 see the following plates in the 1969 Periodic Inspection Report  
Plate B-52 for P-101, P-117 & P-134  
Plate B-54 for P-116 & Total Powerhouse Sump Drain Discharge

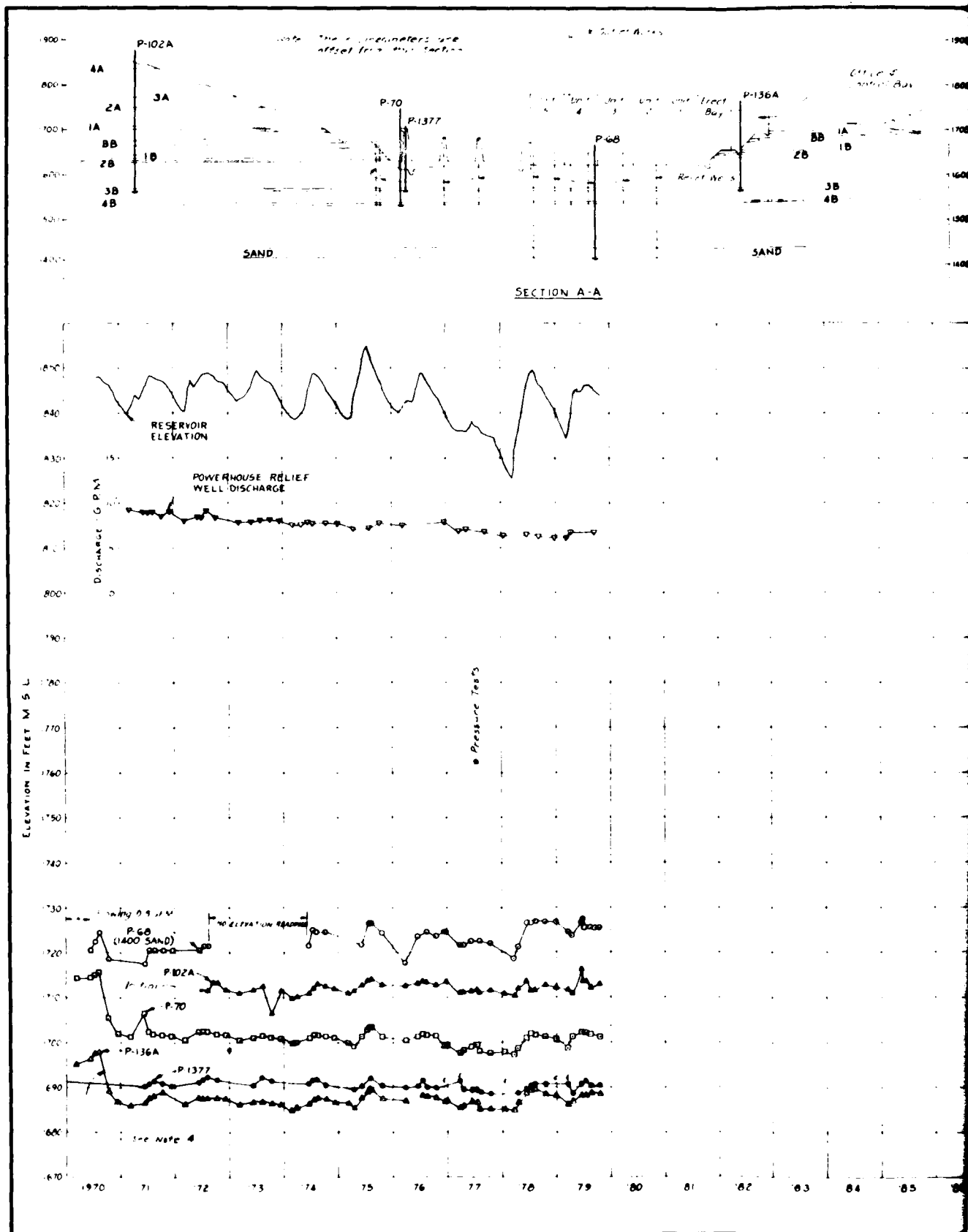
THIS DRAWING HAS BEEN REDUCED TO THREE-FOURTHS THE ORIGINAL SCALE

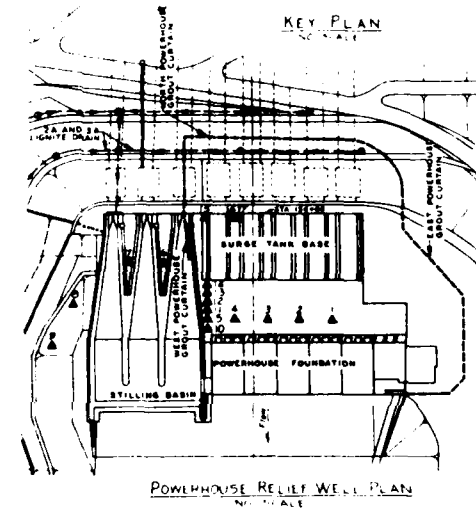
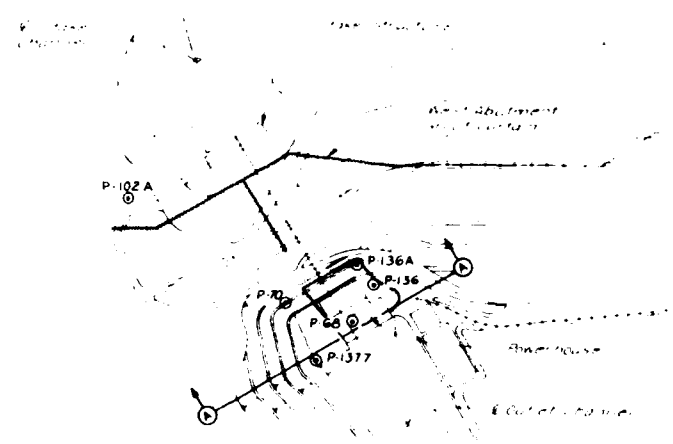
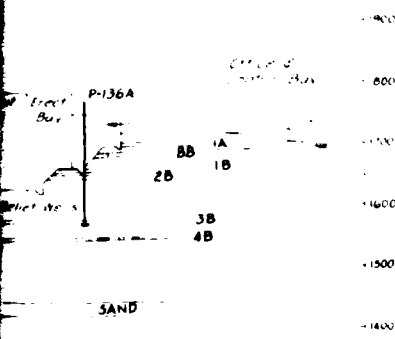


THIS PLAN ACCOMPANIES CONTRACT NO. \_\_\_\_\_  
MODIFICATION NO. \_\_\_\_\_

U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA	
MISSOURI RIVER <b>GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES WEST ABUTMENT PIEZOMETERS IB LIGNITE AND POWERHOUSE SUMP DRAIN OBSERVATIONS</b>	
DESIGNED BY: _____	DATE: _____
DRAWN BY: _____	SCALE AS SHOWN
CHECKED BY: _____	DATE: _____
APPROVED BY: _____	DATE: _____

2





POWERHOUSE RELIEF WELL PLAN  
NOT TO SCALE

- Note:
1. Piezometer 102A was plugged 4-15-72
  2. Piezometer 102A initial reading 8-17-72
  3. Piezometer 136 flowing at 004 GPM, less
  4. Relief wells 10 thru 17 installed Sept. 1970
  5. 17-18-72

Note:  
For data prior to 1970 see Plate B 50  
1969 Periodic Inspection Report

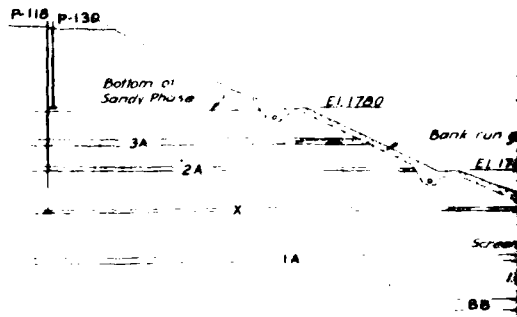
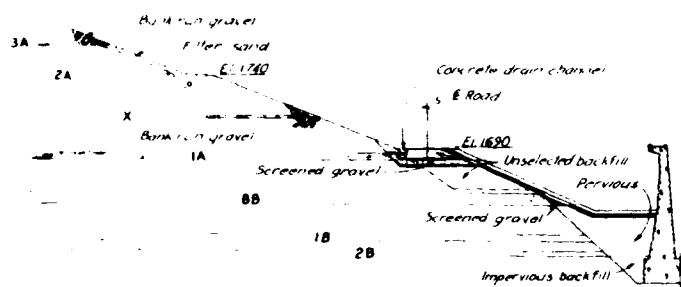
17-18-72 was being reduced to  
17-18-72 was being reduced to

Pressure Tests were conducted  
in June, July and August 1972  
and all piezometers remained  
well



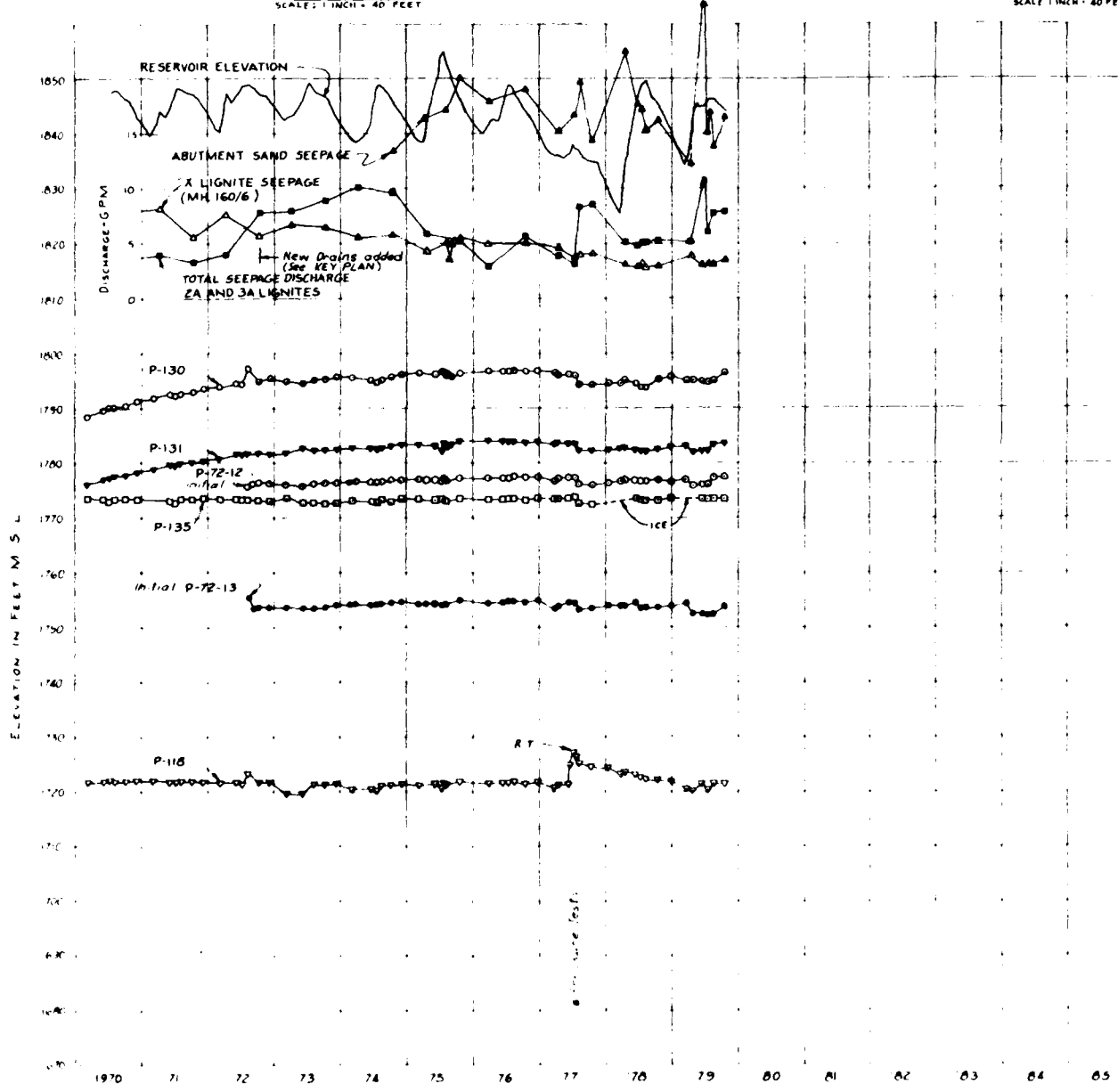
DATE	DESCRIPTION	MADE	APPROVED
REVISED			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
DESIGNED BY	MAJOR R. L. R.		
DRAWN BY	GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES		
CHECKED BY	WEST ABUTMENT PIEZOMETERS 1400 SAND, 3B & 4B LIGNITE AND POWERHOUSE RELIEF WELL DISCHARGE		
DATE	APPROVED	DATE	APPROVED
DATE	APPROVED	DATE	APPROVED
DATE	APPROVED	DATE	APPROVED

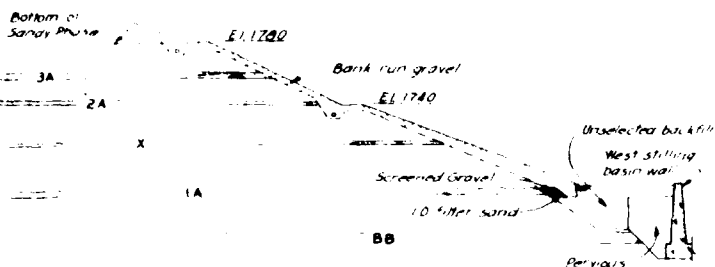
THIS PLAN ACCOMPANIES CONTRACT NO. \_\_\_\_\_  
MODIFICATION NO. \_\_\_\_\_



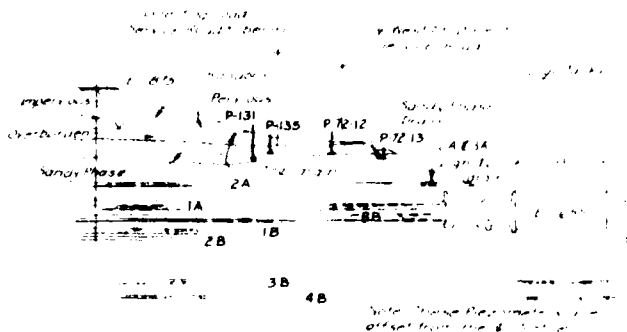
SECTION A-A  
SCALE 1 INCH = 40 FEET

SECTION B-B  
SCALE 1 INCH = 40 FEET

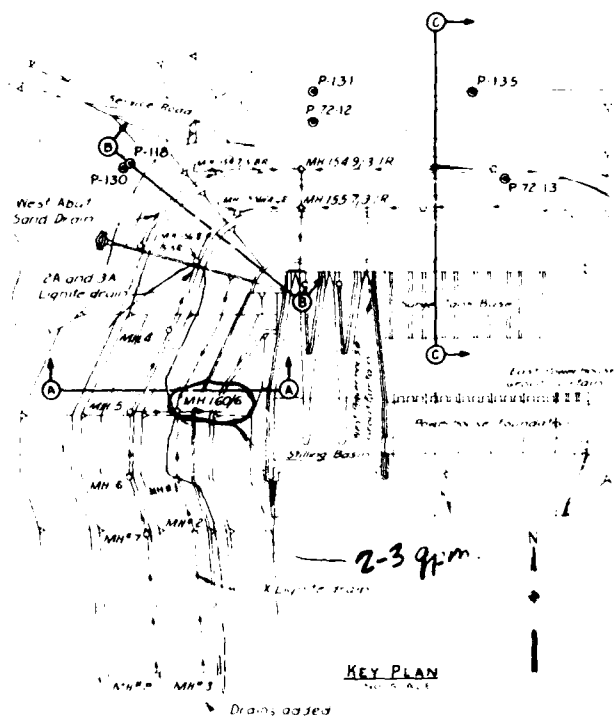




**SECTION B-B**  
SCALE 1 INCH = 40 FEET



OUTLET WORKS & PROFILE C.C.  
1/4" VERT. LINE = 10 FEET



**Note:**

Notes

- 1. There are 3 responses to a page from the Analysis 9
- 2. 10/11/12 10/11/13 10/11/14 10/11/15 10/11/16
- 3. 10/11/17 10/11/18 10/11/19 10/11/20 10/11/21
- 4. K.T. & Response Test

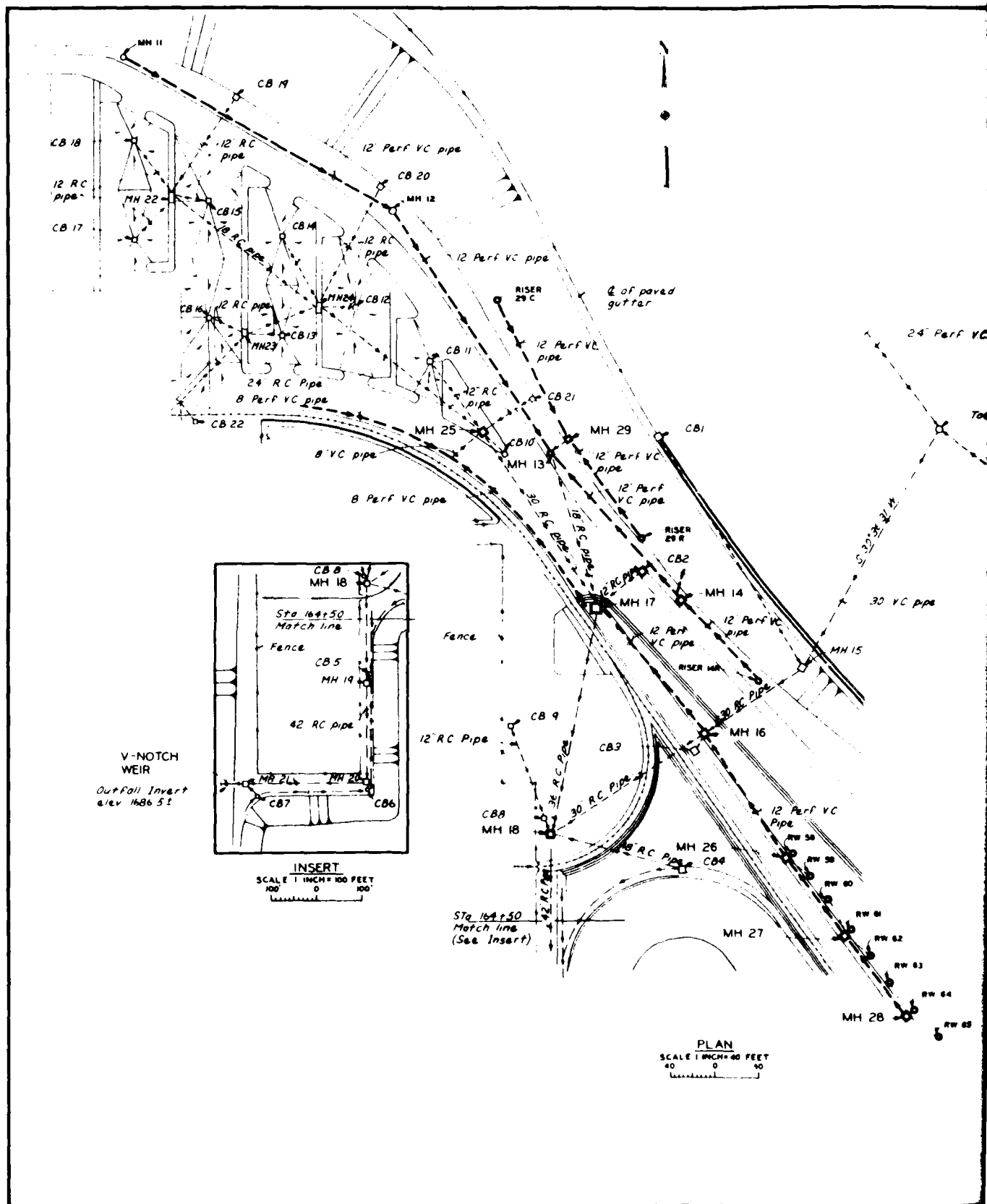
*Note*

For data prior to 1970 see the following plates  
in the 1969 Periodic Inspection Report:  
Plate B-60 for P-18 & Sewage Discharges  
Plate B-62 for P-180, P-131 & P-135

\* Pressure tests were carried out in the middle July and August 1961 and in May 1962, respectively, and were excepted from the analysis. This is plotted in the next section.

[illegible]

THIS PLAN ACCOMPANIES CONTRACT NO. \_\_\_\_\_  
MODIFICATION NO. \_\_\_\_\_



MH 25	SW LEG
MH 13	NW LEG
	NE LEG
	SE LEG
MH 17	NW LEG (18 R C P)
	SE LEG
MH 16	SE LEG
MH 15	NE LEG

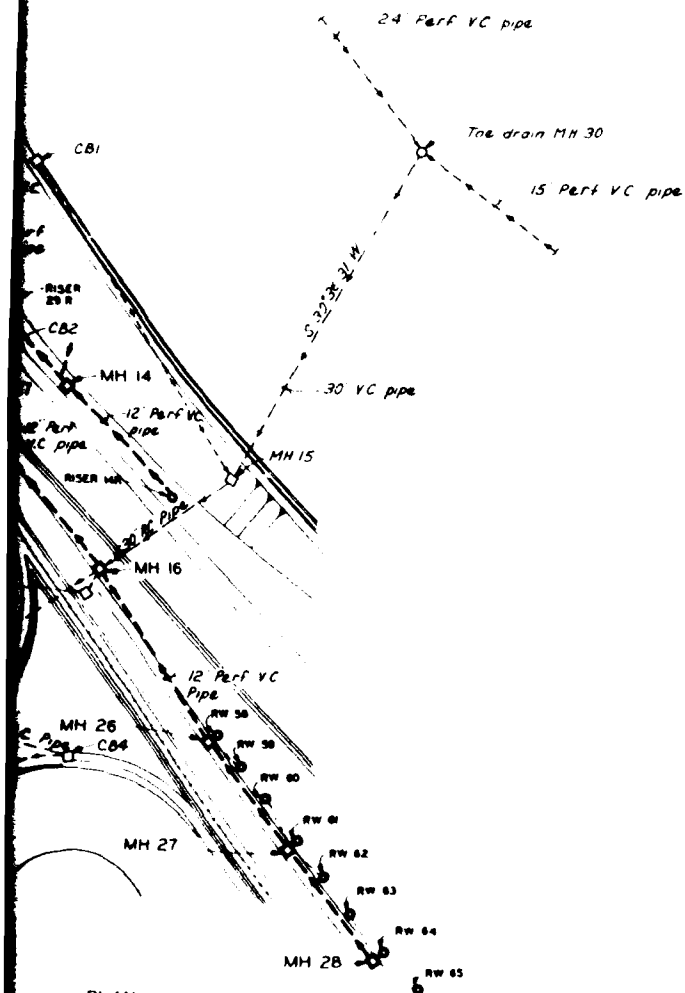
TF = Total seepage flow from switchyard drainage system

$$TF = (MH\ 25\ SW\ LEG) + (MH\ 17\ SE\ LEG) +$$

$$(MH\ 17\ NW\ LEG) + (MH\ 16\ SE\ LEG) -$$

$$(MH\ 15\ NE\ LEG)$$

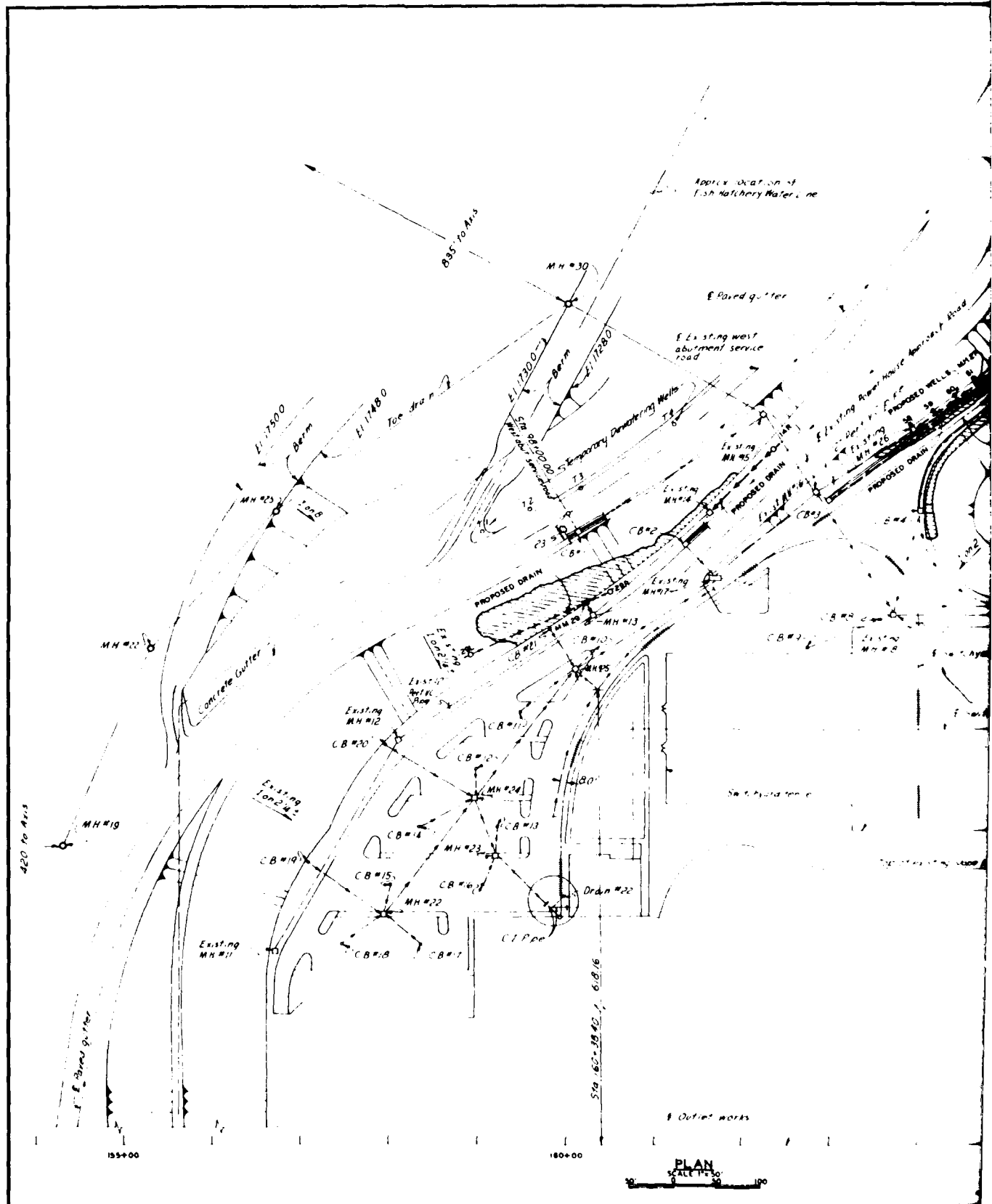
RC = Reinforced Concrete  
VC = vitrified Clay  
MH = Manhole  
RW = Relief Well  
CB = Catch Basin



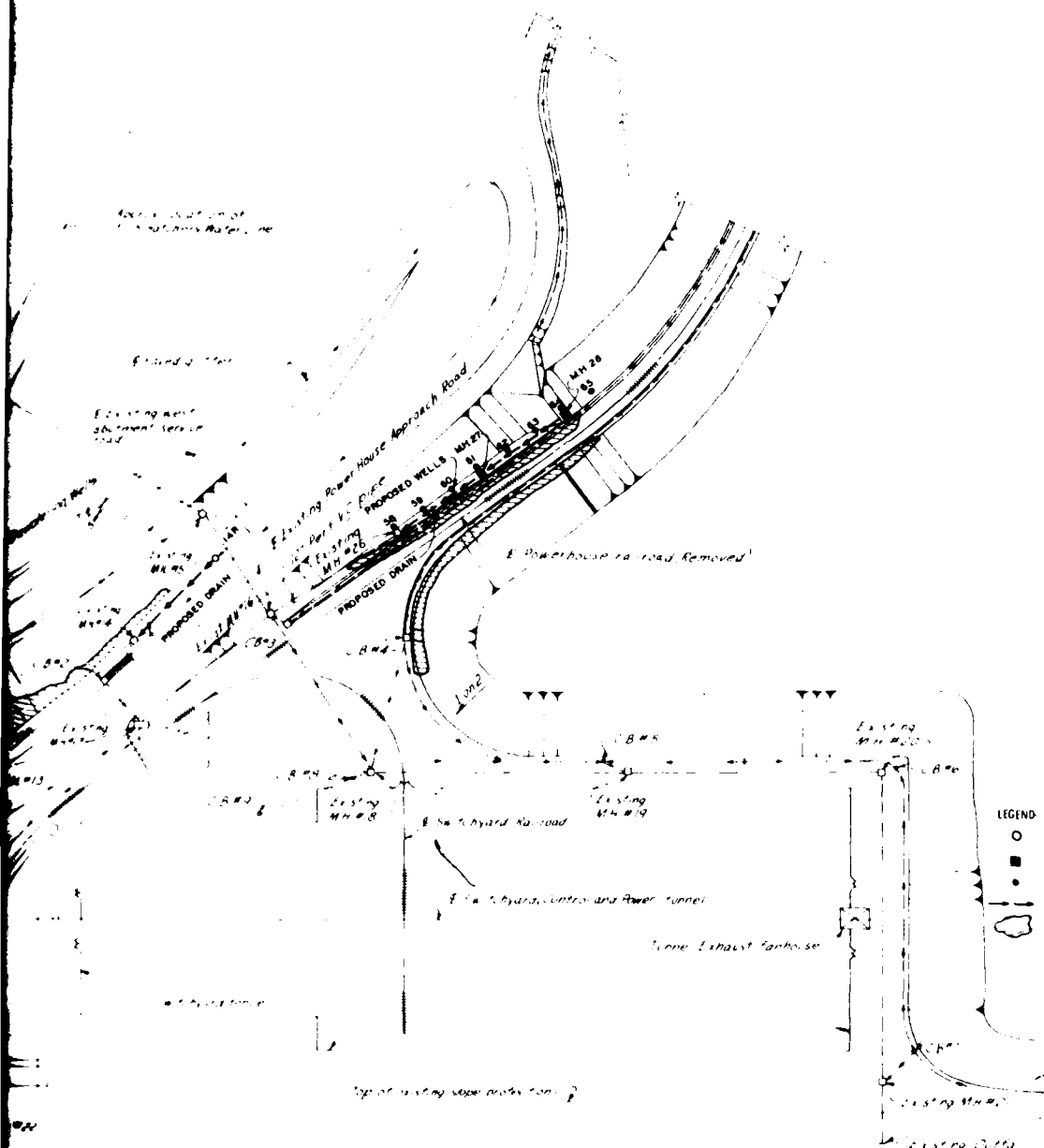
IN 3 2000 PM HAS BEEN REPORTED TO  
WILLIAM GUYTON FOR 2000 NO. 3241

[illegible]

THIS PLAN ACCOMPANIES CONTRACT NO. 04C481 MODIFICATION NO.





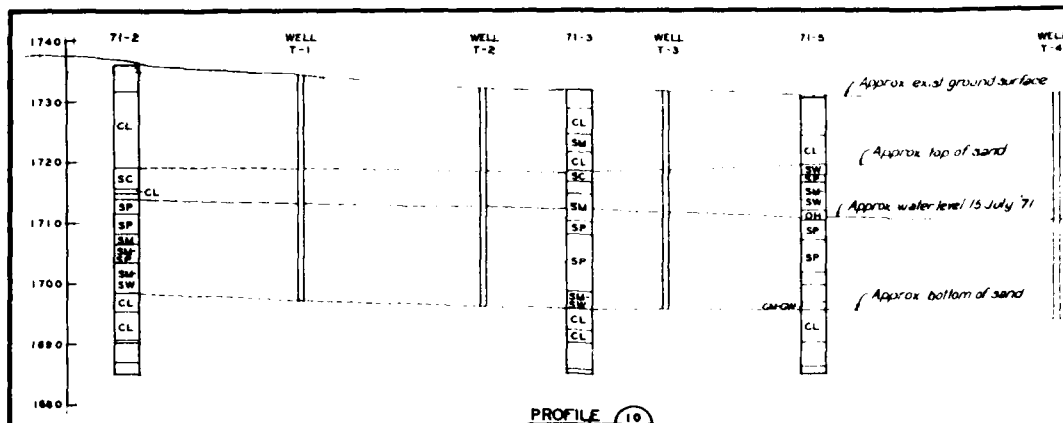


LEGEND

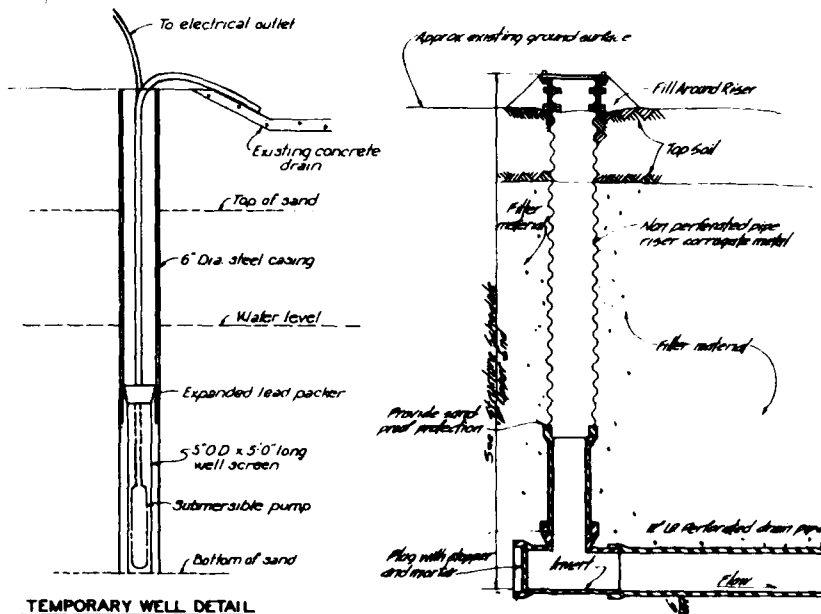
- Proposed Rivers
- Proposed Manholes
- Proposed Wells
- Proposed Drain Pipe
- Approximate areas observed wet during Periodic Inspection, September, 1969.



DATE		REVISIONS		GRADE	APPROVED
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA					
MISSOURI RIVER GARRISON DAM-LAKE SAKAKAWEA WEST TERRACE GRAVEL UNDERSEEPAGE DRAINAGE PLAN					
DESIGNED BY: J. E. M.	CHECKED BY: J. E. M.	APPROVED BY: J. E. M.	DATE: JAN 1972	SCALE AS SHOWN	
BY: J. E. M.			DATE: JAN 1972		
BY: J. E. M.			DATE: JAN 1972		

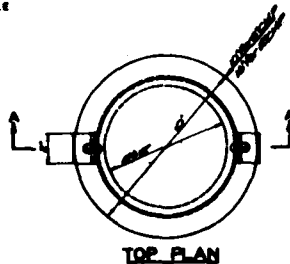


PROFILE 10

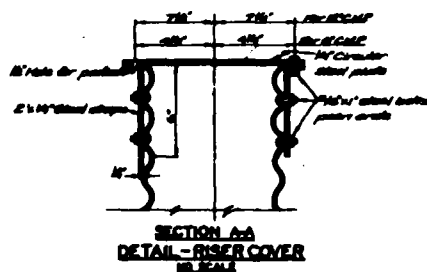


TEMPORARY WELL DETAIL  
NO SCALE

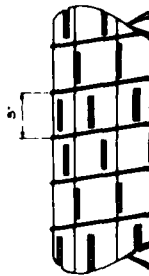
OBSERVATION RISER  
NO SCALE



TOP PLAN



SECTION AA  
DETAIL - RISER COVER  
NO SCALE



WOOD PIPE WELL  
NO SCALE

STANDARD PRECAST

SCALE 1/2" = 1'-0"

LOCATION			ELEVATIONS			LENGTH	
WELL NO.	STA.	RANGE	BOTTOM SCREEN	TOP SCREEN	TOP RISER	OUTFALL INVERT	WELL SCREEN
58	0+00	5' LT.	1668.5	1696.05	1709.0	1697.40	28.25
59	0+30	3' LT.	1666.5	1696.05	1709.0	1697.40	30.25
60	0+60	3' LT.	1664.5	1696.05	1709.0	1697.70	32.45
61	0+90	3' LT.	1662.5	1696.05	1709.0	1697.70	34.45
62	1+20	3' LT.	1660.5	1696.05	1709.0	1697.70	36.45
63	1+50	3' LT.	1658.5	1697.25	1710.0	1698.00	38.75
64	1+80	3' LT.	1657.0	1697.25	1713.0	1698.00	40.25
65	2+10	3' LT.	1655.0	1697.25	1713.0	1698.00	42.25

\* 6" DIA. RISER - STA. 0+00

FROM		TO		RIM ELEV.		INV. ELEV.		SLOPE FT. PER
TYPE	NO.	TYPE	NO.	UPPER END		FROM	TO	
M.H.	26	M.H.	27	1705.0		1696.48	1696.70	.003
M.H.	27	M.H.	28	1705.0		1696.70	1697.00	.003
M.H.	28	M.H.	29	1705.0		1697.00	1697.00	.003
OR	29	OR	29	1711.0		1706.00	1697.00	.007
M.H.	29	OR	29	1706.0		1697.0	1697.00	.003
OR	29	OR	29	1706.0		1697.25	1697.25	.003
M.H.	29	M.H.	33	1706.0		1697.0	1697.04	.003
M.H.	34	OR	14R	1706.0		1706.07	1706.97	.003
OR	14R	OR	14R	1711.0		1706.97	1706.97	.003

\* NON PERFORATED PIPE

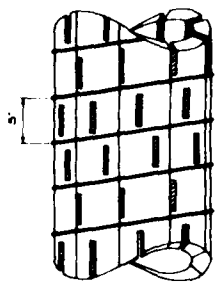
WELL  
T-4

Approx. ex. d. ground surface

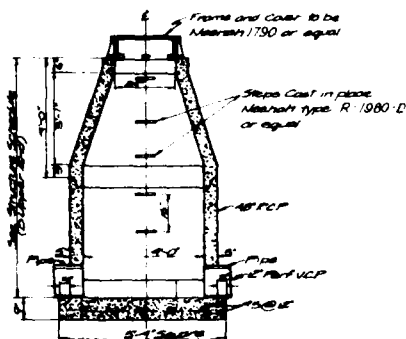
Approx. top of sand

Approx. water level 15 July '71

Approx. bottom of sand

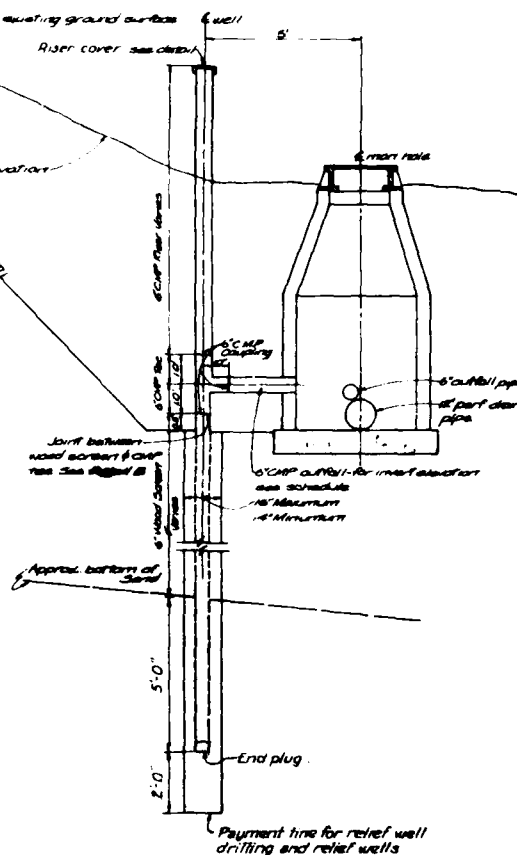


6" O.D. Wood well screen with 4"x4" x 1/2" spaced 9" apart, spaced with vertical rows staggered as shown

WOOD PIPE WELL SCREEN  
NO SCALE

STANDARD PRECAST CONCRETE MANHOLE

SCALE: 1/2" = 1 FOOT



RELIEF WELL DETAIL

SCALE: 1/2" = 1 FOOT

RELIEF WELL SCHEDULE

WELL NO.	LOCATION		ELEVATIONS			LENGTH		C. M. P. DISCHARGE OUTFALL	
			BOTTOM SCREEN	TOP SCREEN	TOP RISER	OUTFALL INVERT	WELL SCREEN	RISER PIPE	SIZE
58	0+00	5' LT.	1668.5	1696.85	1709.0	1697.40	28.15	10.35'	2.17' 6"
59	0+30	3' LT.	1666.5	1696.85	1709.0	1697.40	30.15	10.35'	27.32' 6"
60	0+60	3' LT.	1664.5	1696.95	1709.0	1697.70	32.45	10.05'	27.32' 6"
61	0+90	3' LT.	1662.5	1696.95	1709.0	1697.70	34.45	10.05'	2.17' 6"
62	1+20	3' LT.	1660.5	1696.95	1709.0	1697.70	36.45	10.05'	27.32' 6"
63	1+50	3' LT.	1658.5	1697.25	1710.0	1698.00	38.75	10.75'	27.32' 6"
64	1+80	3' LT.	1657.0	1697.25	1713.0	1698.00	40.25	13.75'	2.17' 6"
65	2+10	3' LT.	1655.0	1697.25	1713.0	1698.00	42.25	13.75'	27.32' 6"

\* 6" NON PERFORATED PIPE

MANHOLE STRUCTURE SCHEDULE

FROM		TO		RIM ELEV.		INV. ELEV.		SLOPE FT. FT.	¢ TO ¢ DIST.	D. UPPER END
TYPE	NO.	TYPE	NO.	UPPER END	FROM	TO				
AL H.	26	AL H.	27	1705.0	1696.40	1696.70	.003	90'	...	...
AL H.	27	AL H.	28	1705.0	1696.70	1697.00	.003	90'	...	8.30'
AL H.	28	...	...	1707.0	1697.00	...	...	...	...	10.00'
OR	29	AL H.	29	1711.0	1706.60	1697.00	.067	143'	...	4.40'
AL H.	29	OR	29R	1706.0	1697.0	1697.25	.025	30'	...	...
OR	29R	...	...	1704.0	1697.15	...	...	...	...	4.85'
AL H.	29	AL H.	33	1706.0	1697.0	1697.44	...	141.2'	...	9.80'
AL H.	34	OR	34R	1706.47	1701.97	...	.065	100'	...	...
OR	34R	...	...	1711.0	1701.97	...	...	...	...	9.80'

\* NON PERFORATED PIPE

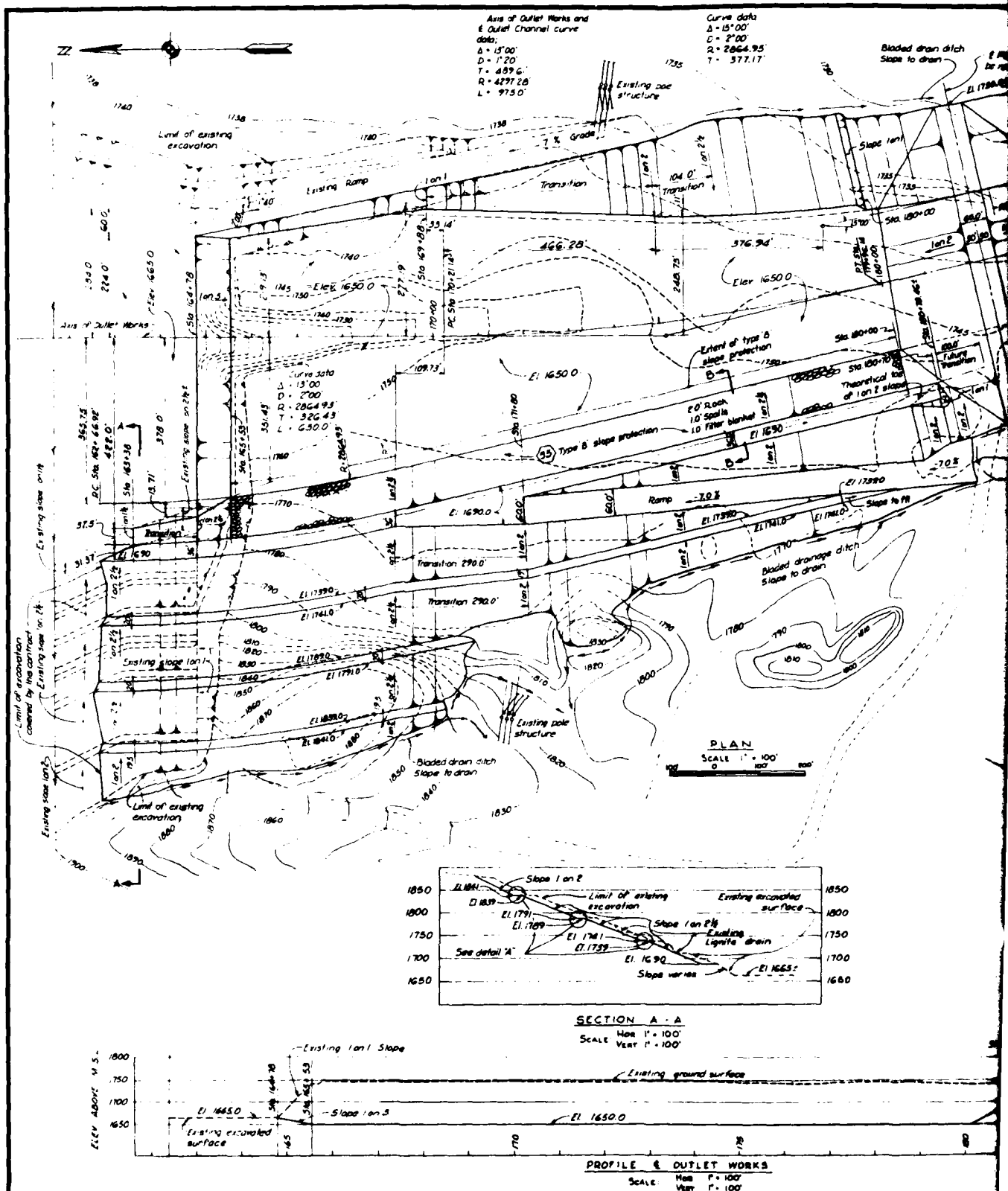
THIS PLAN AND SPECIFICATIONS CONTRAST NO.  
MODIFICATION NO.

DATE		REVISION		NO.	DATE
DIVISION					
U. S. ARMY ENGINEER DISTRICT, OMAHA BUREAU OF ENGINEERS OMAHA, NEBRASKA					
DESIGNED BY: B. J. H.		CHECKED BY: B. J. H.		DATE: JAN 1972	
DRAWN BY: C. J. A.		CHECKED BY: C. J. A.		DATE: JAN 1972	
APPROVED BY: B. J. H.		CHECKED BY: B. J. H.		DATE: JAN 1972	
APPROVED BY: B. J. H.		CHECKED BY: B. J. H.		DATE: JAN 1972	
MISSOURI RIVER GARRISON DAM-LAKE SAKAKAWEA WEST TERRACE GRAVEL UNDERSEEPAGE MANHOLE, RISER AND WELL DETAILS					
APPROVED BY: B. J. H.		CHECKED BY: B. J. H.		DATE: JAN 1972	
APPROVED BY: B. J. H.		CHECKED BY: B. J. H.		DATE: JAN 1972	

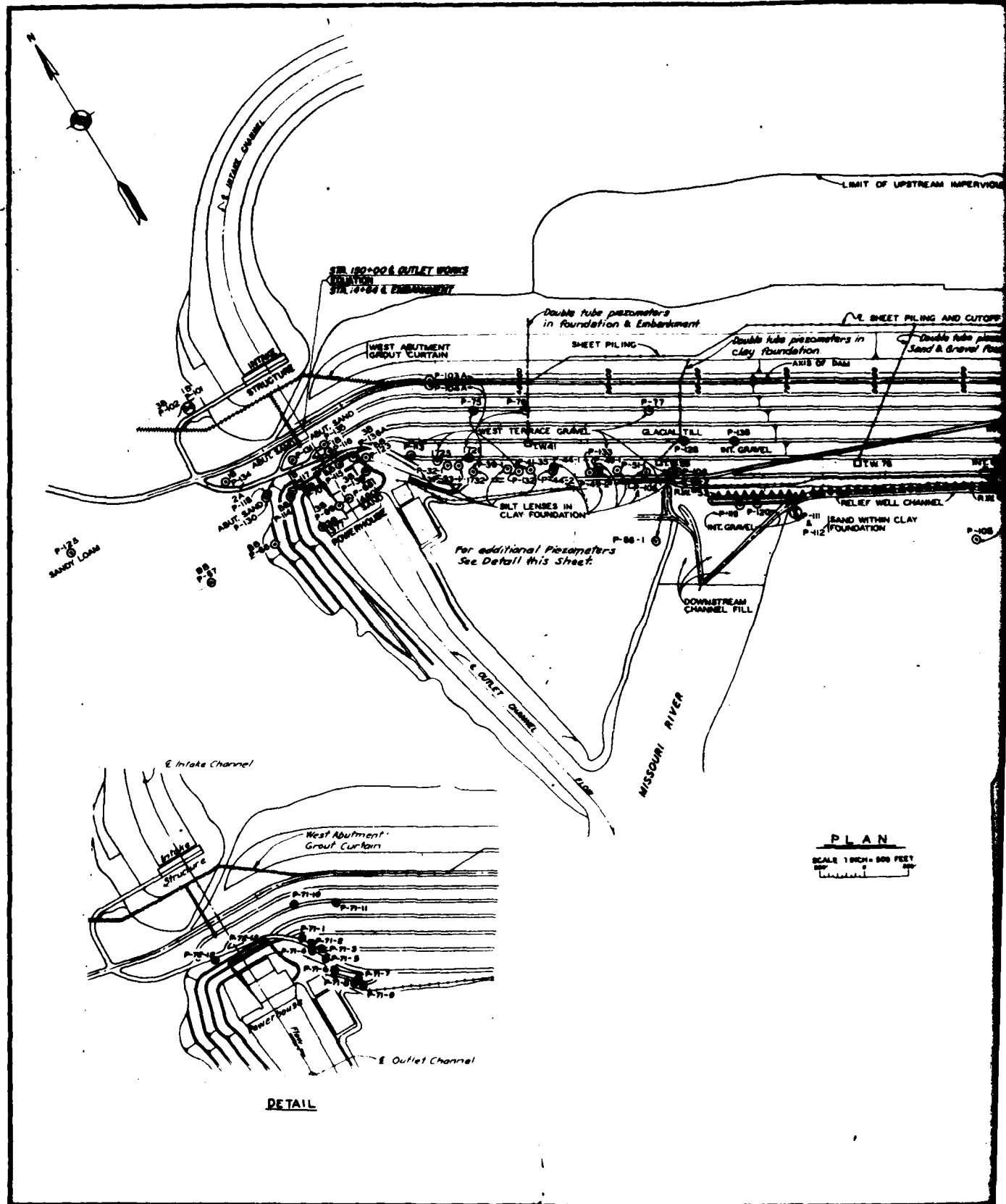
CONSTRUCTION FOUNDATION REPORT

(1982)

PLATE 125



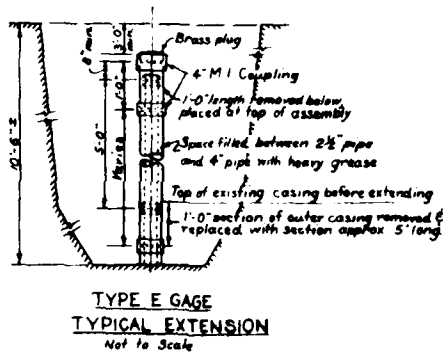
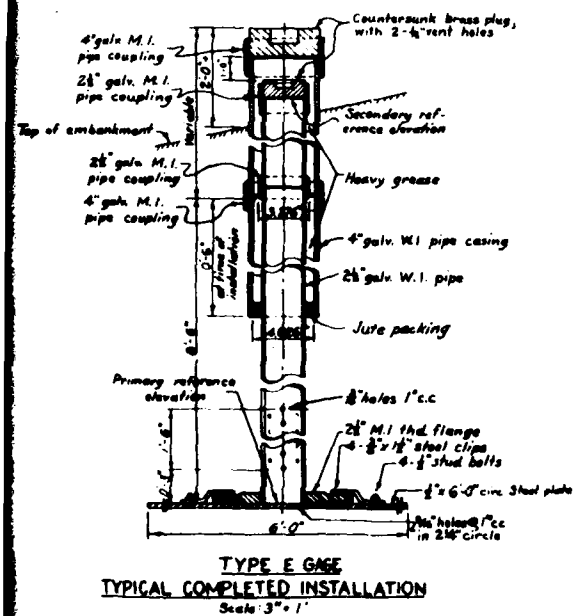
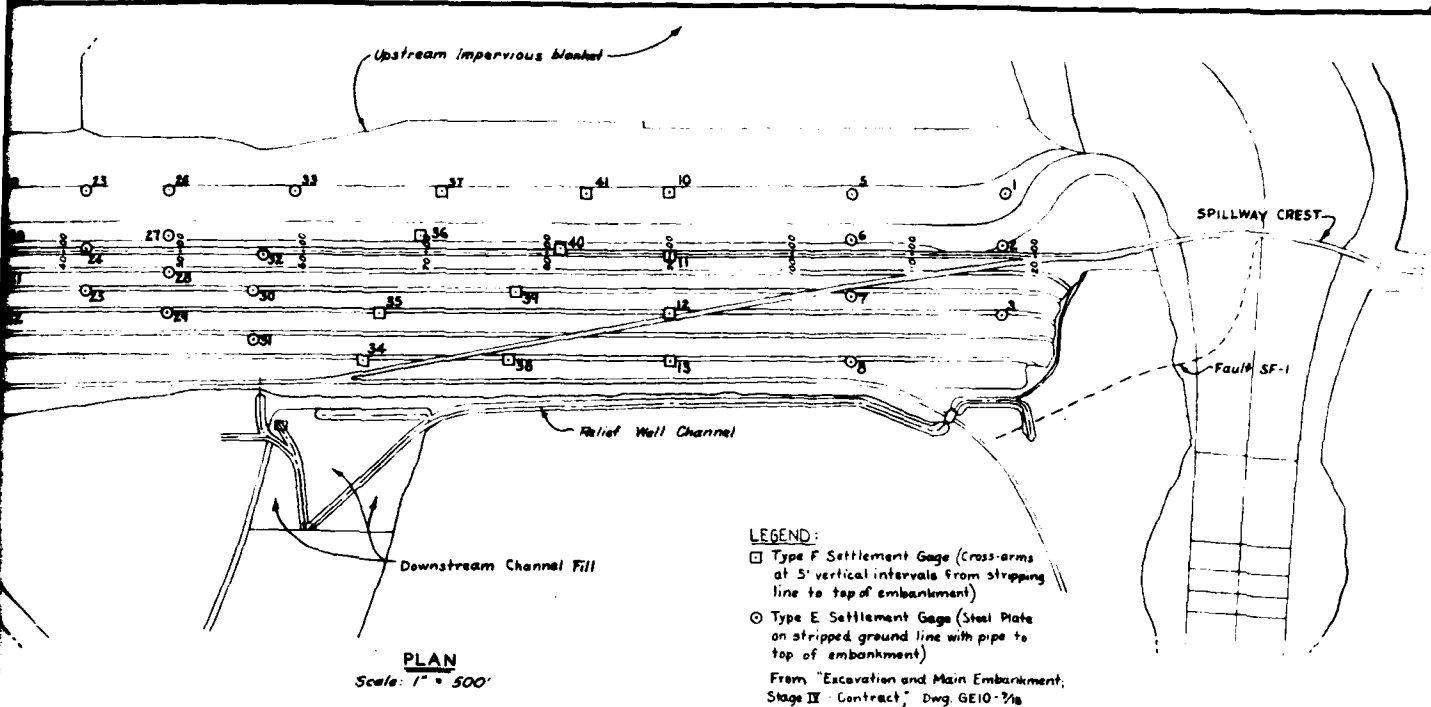












THIS DRAWING HAS BEEN REDUCED TO  
THREE-EIGHTH THE ORIGINAL SCALE.

DATE	DESCRIPTION	NAME	STATUS
	REVISIONS		
U. S. ARMY ENGINEER DISTRICT, OMAHA DIVISION OF ENGINEERING OMAHA, NEBRASKA			
PROJECT: GARRISON DAM - LAKE SARAWAKA EMBAKMENT-FOUNDATION STUDIES			
SETTLEMENT GAGES TYPE E & F PLAN AND DETAILS			
DESIGNED BY: C. E. K.	CHECKED BY: C. E. K.	DATE: SEP 1975	SCALE: AS SHOWN
APPROVED BY: [Signature]		DESIGNED BY: [Signature]	



THIS PLAN ASSIGNED CONTRACT NO.  
MODIFICATION NO.

**FENCE DETAILS**  
NOT TO SCALE

Well head

5 ft Length protection casing string

Packer

5 ft

Perforation layer (sand, or gravel, or lignite)  
Lignite layer to be pressure tested for permeability

5 ft

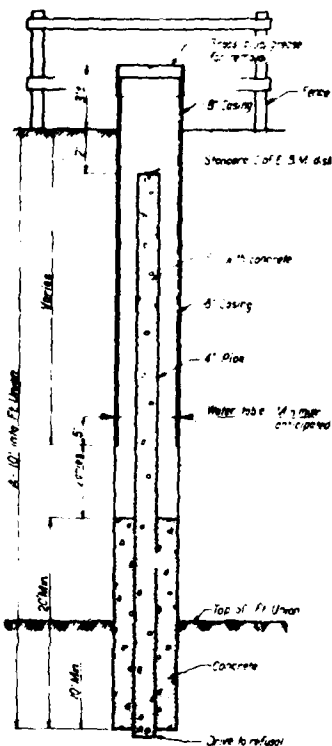
Perforation layer (sand, or gravel, or lignite)  
Lignite layer to be pressure tested for permeability

5 ft

Perforation layer (sand, or gravel, or lignite)  
Lignite layer to be pressure tested for permeability

5 ft

Perforation layer (sand, or gravel, or lignite)  
Lignite layer to be pressure tested for permeability



Note: Multiple evaluation not over 3 parameters per hole when distance between various layers around 50' and stratification such as to permit sampling between tips of adjacent parameters, otherwise eval only 1 parameter per hole.

**UNDERGROUND**  
**BENCH MARK**  
NOT TO SCALE

- 1. Sperm are to be given 2" inside eye - under eyelid eye
- 2. Filter sand to be given one medium
- 3. Sperm are to be 3" and by 1/2" of 1/2" - infers and being centrally with 1" secretion

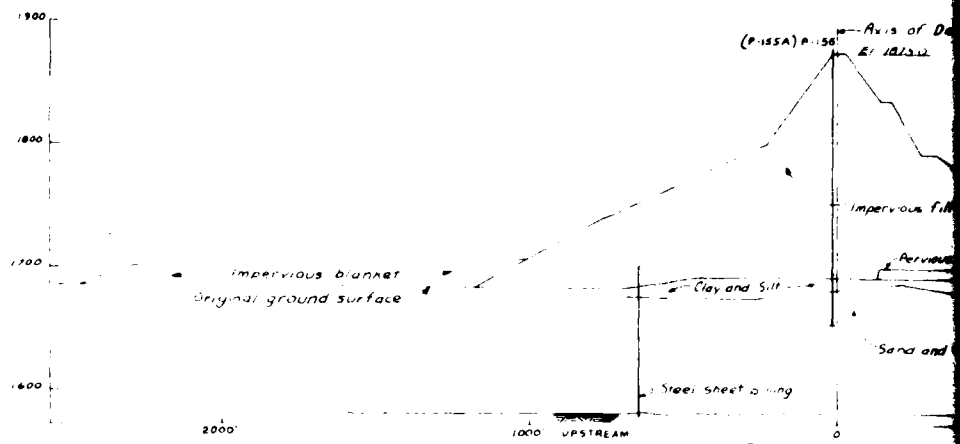
THIS DOCUMENT HAS BEEN REPRODUCED  
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ORGANIZATION ORIGINATING IT. POINTS OF  
VIEW OR OPINIONS STATED HEREIN ARE  
THOSE OF THE PERSON OR ORGANIZATION  
ORIGINATING THEM AND DO NOT NECESSARILY  
REPRESENT THE OFFICE OF THE DIRECTOR  
OF NATIONAL ARCHIVES.

U S ARMY  
 CORPS OF ENGINEERS  
 OFFICE OF THE DISTRICT ENGINEER  
 ATLANTA 3 3

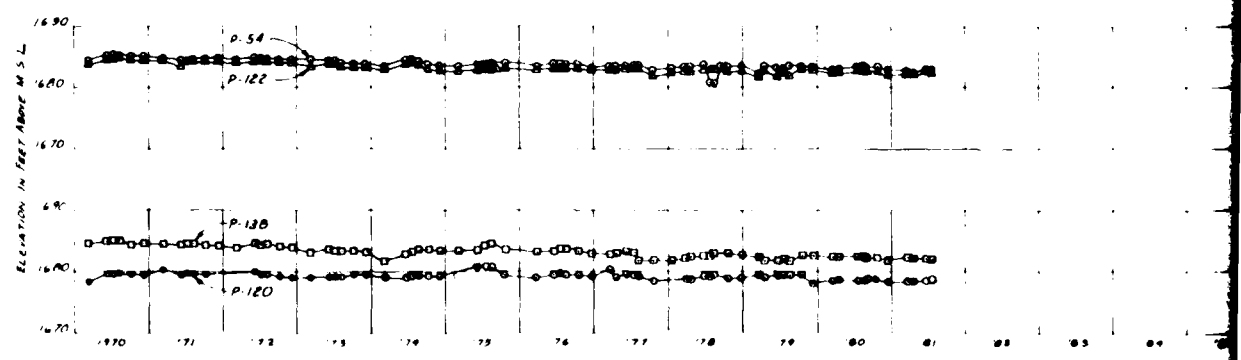
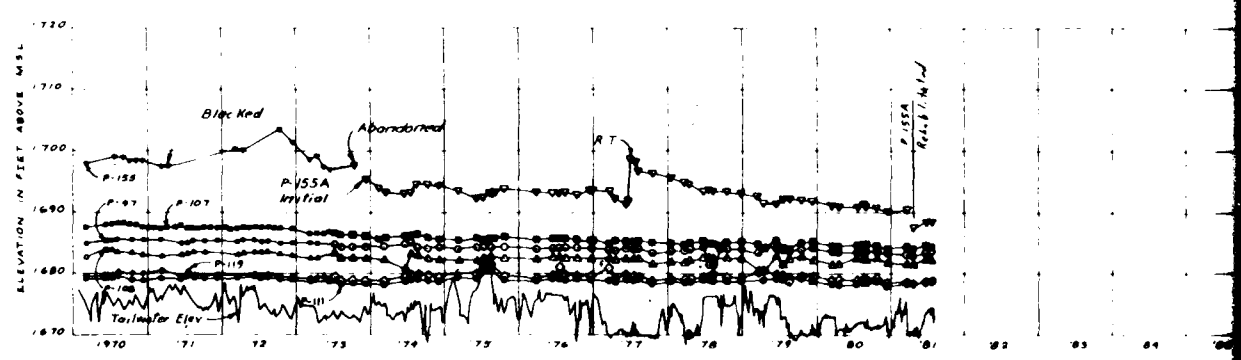
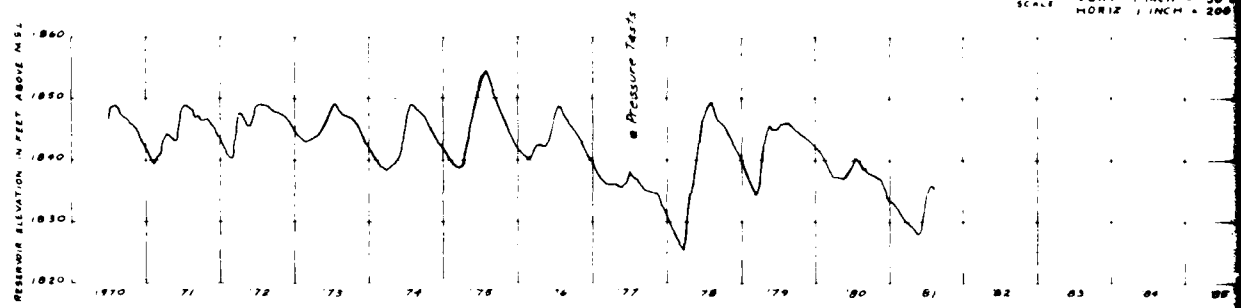
MISSOURI RIVER  
 GARRISON DAM AND RESERVOIR  
 OPERATION & MAINTENANCE MANUAL  
 PEZOMETERS AND UNDERGROUND BENCH MARK DETAILS

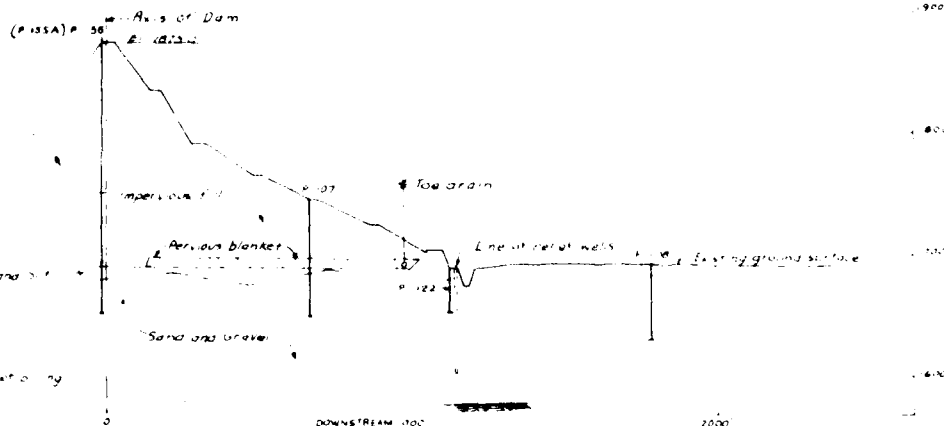
OCTOBER 1953

[Handwritten signatures and stamps are visible on the document, including a date stamp "OCT 19 1953" and a signature "R. H. ..."]

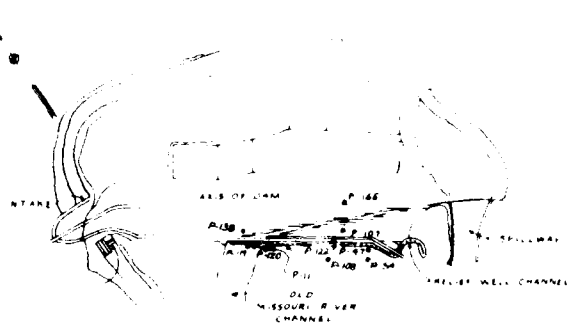


SECTION AT STA 96+00  
 SCALE VERT 1 INCH = 50 FT  
 HORIZ 1 INCH = 200 FT





SECTION AT STA 96+00  
 VERT 1 INCH = 50 FEET  
 HORIZ 1 INCH = 200 FEET



KEY PLAN  
 NO SCALE

Note: Pressure tests were conducted on the piezometers and the results are shown in the report for the P-107, P-122, and P-123 tests.

Note

1. P-107 is replaced by P-108 at Sta 95+73  
 Top of pipe elev 875.0

2. P-122 is replaced by P-123 at Sta 96+00

Note

Note: For data prior to 1970 see the following plates in the 1969 Periodic Inspection Report:  
 Plate B-10 for Relief Well Discharge  
 Plate B-12 for P-155, P-107, P-108 & P-122

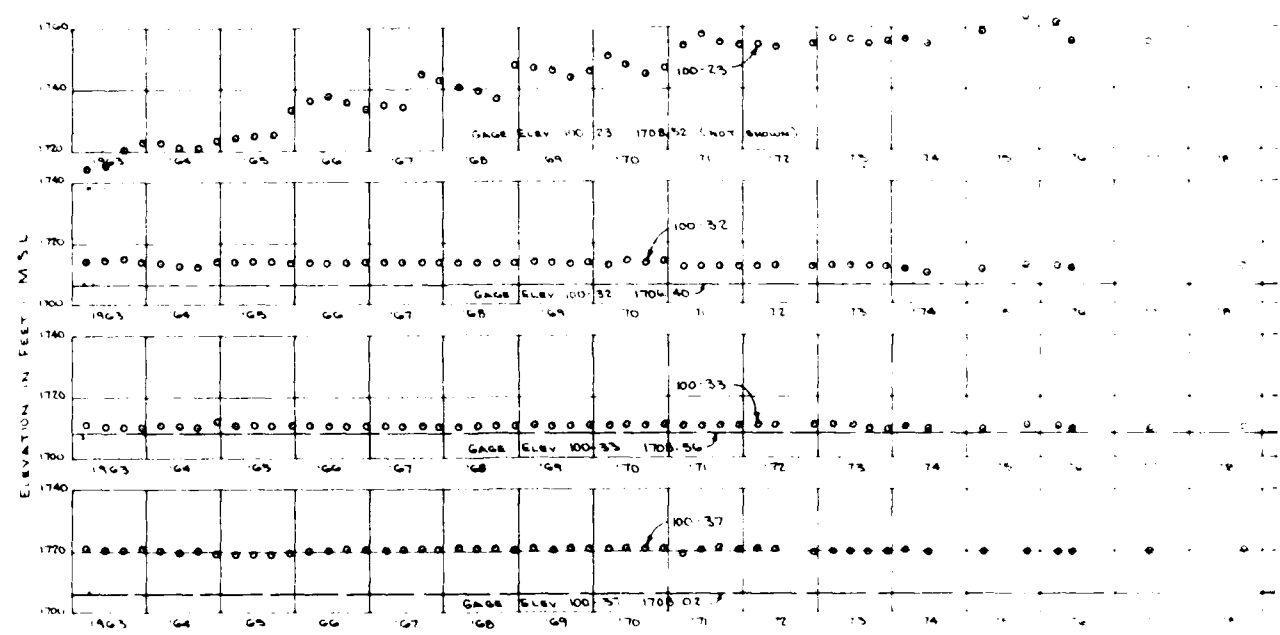
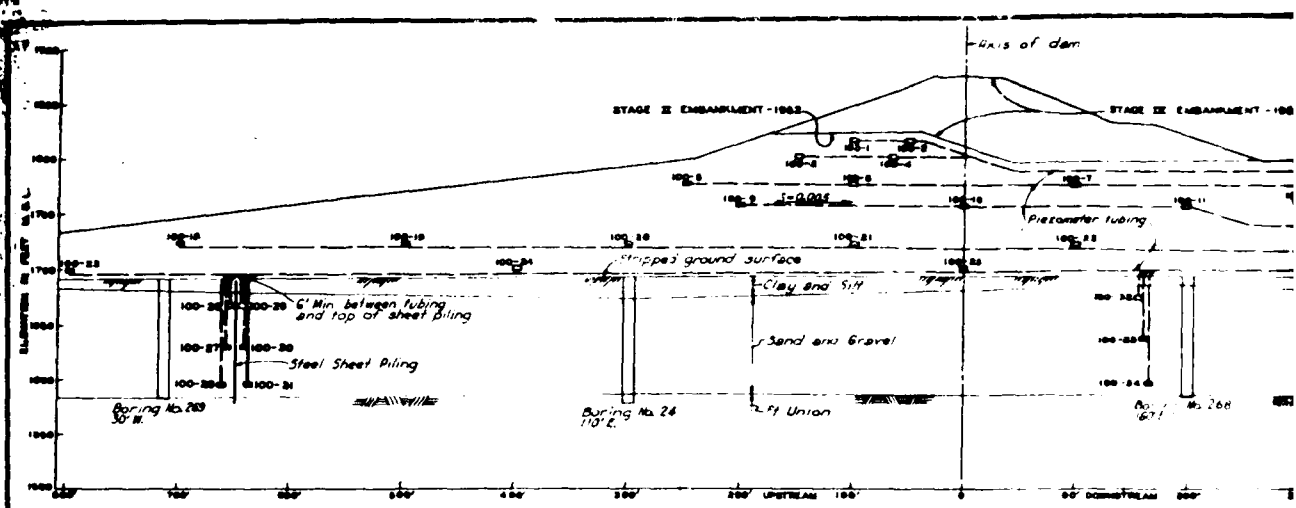
THIS DRAWING HAS BEEN REDUCED TO  
 THREE EIGHTS THE ORIGINAL SCALE

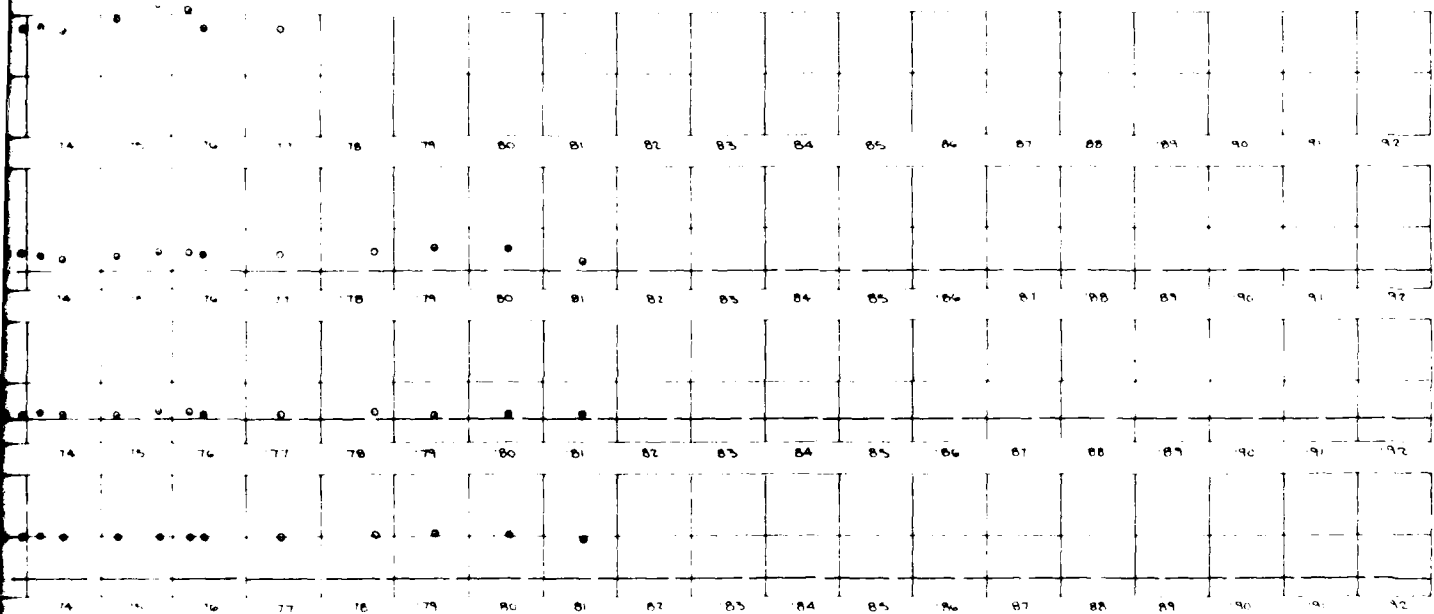
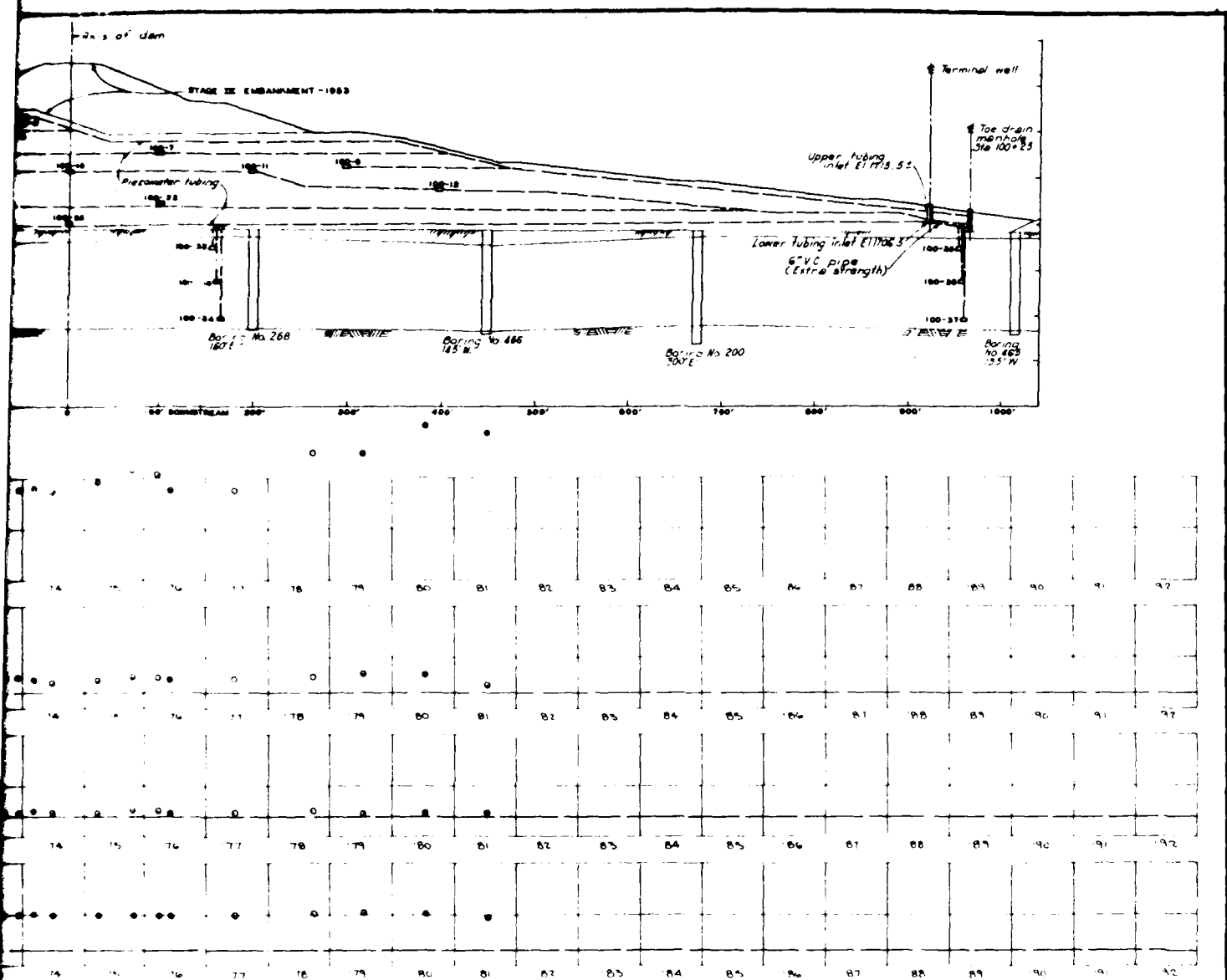


THIS PLAN ACCOMPANIES CONTRACT NO. \_\_\_\_\_  
 MODIFICATION NO. \_\_\_\_\_

DATE		DESCRIPTION		NAME	APPROVE
REVISIONS					
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA					
DESIGNED BY		MISSOURI RIVER			
CHECKED BY		GARRISON DAM AND RESERVOIR			
DRAWN BY		UNDERSEE PAGE STUDIES			
REVIEWED BY		VALLEY PIEZOMETERS			
DATE		INTERMEDIATE GRAVEL PIEZOMETERS			
DATE	APPROVED	DATE			
DATE	APPROVED	DATE			
DATE	APPROVED	DATE			

CONSTRUCTION FOUNDATION REPORT (1982) PLATE 130



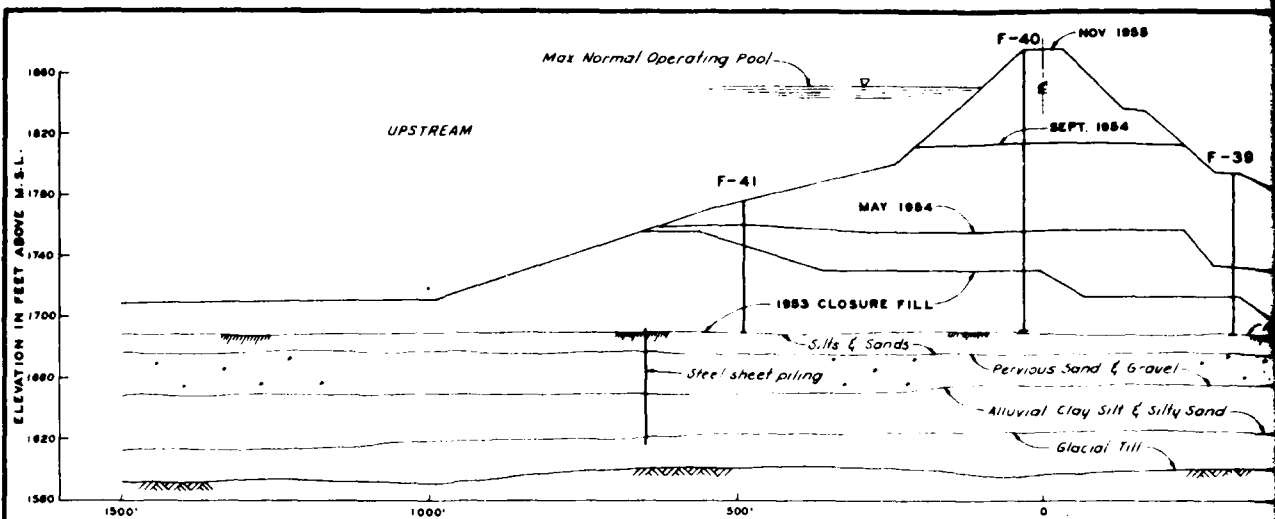


THIS DRAWING HAS BEEN REVISED TO  
INCORPORATE THE ORIGINAL SCALE.

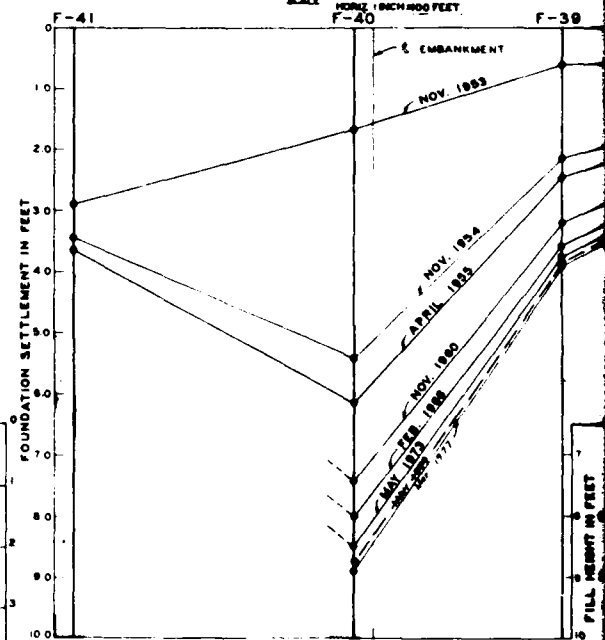
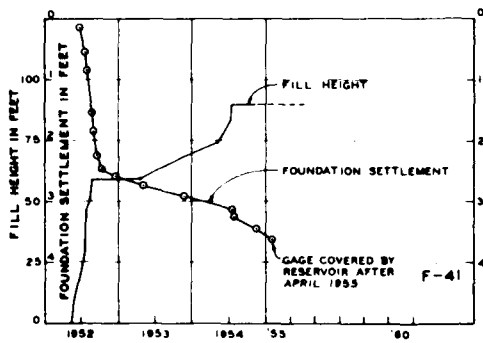


THIS PLAN ACCOMPANIES CONTRACT NO.  
MODIFICATION NO.

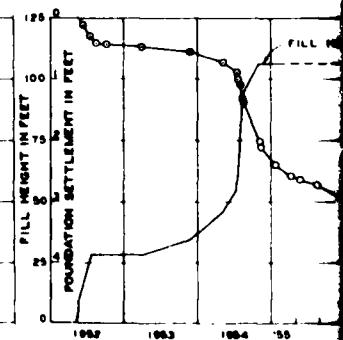
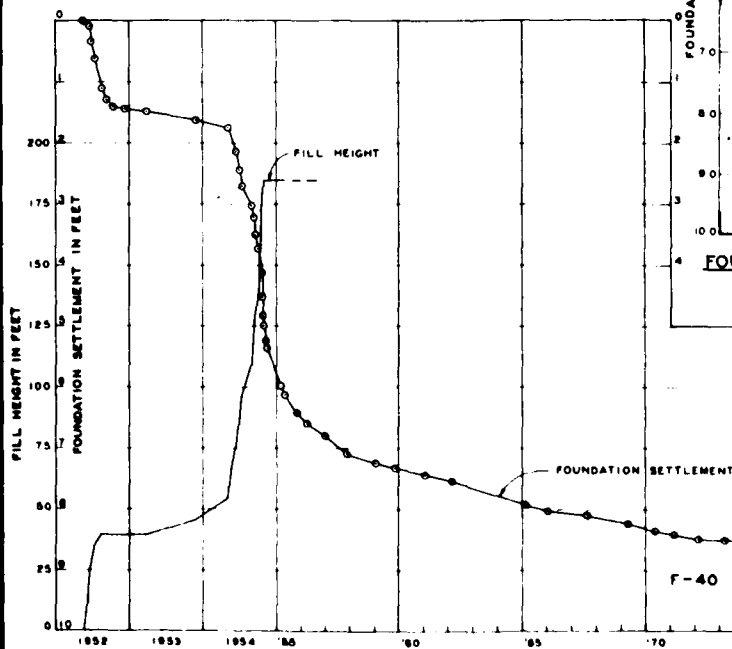
DATE	DESCRIPTION	BY	APPROVED
REVISIONS			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
DESIGNED BY	MISSOURI RIVER		
DRAWN BY	GARRISON DAM - LAKE SAKAKAWA		
CHECKED BY	UNDERMARGA STUDIES		
APPROVED BY	EMBANKMENT PORE PRESSURE		
DATE	OBSERVATIONS STATION 100+00		
DATE	SCALE	DATE	SCALE
DATE	SCALE AS SHOWN	DATE	SCALE



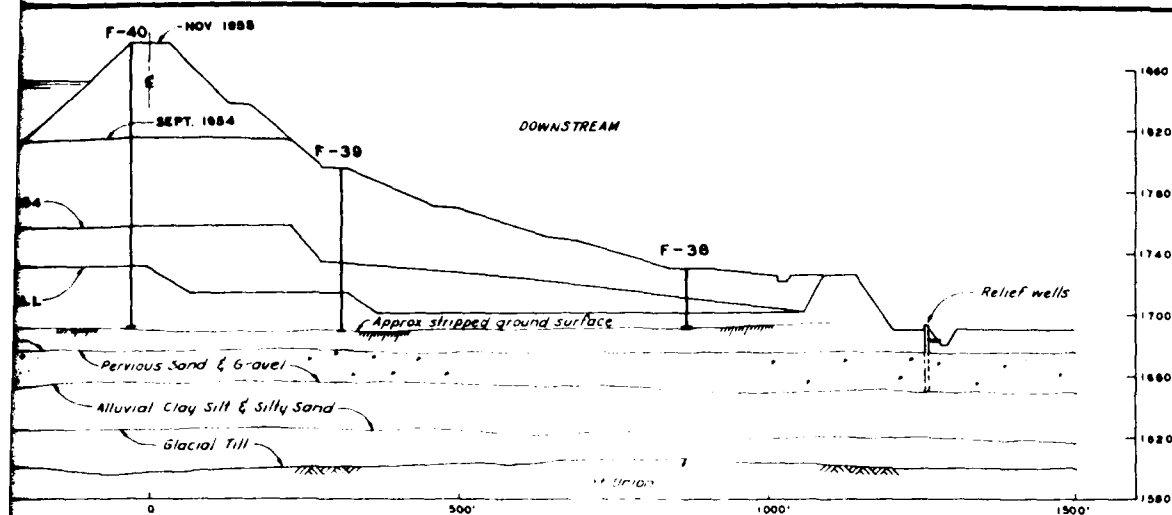
DIAGONAL SECTION 76+90 TO 83+7



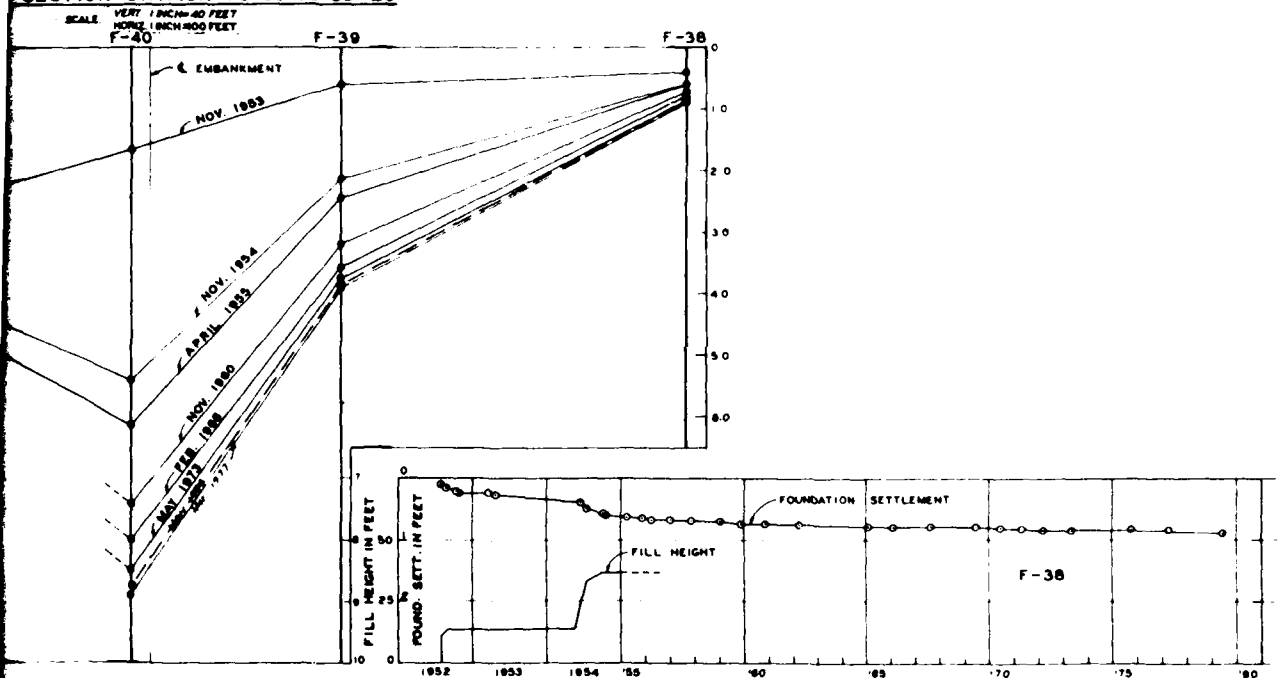
FOUNDATION SETTLEMENT DIAGONAL SECTION



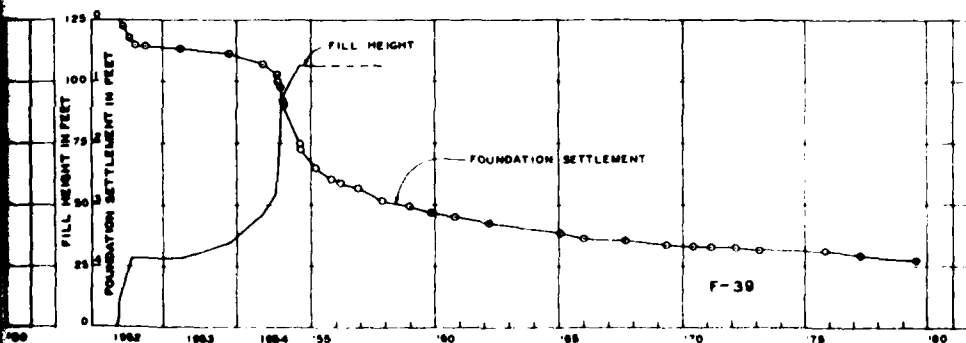




SECTION-STATION 76+90 TO 83+25



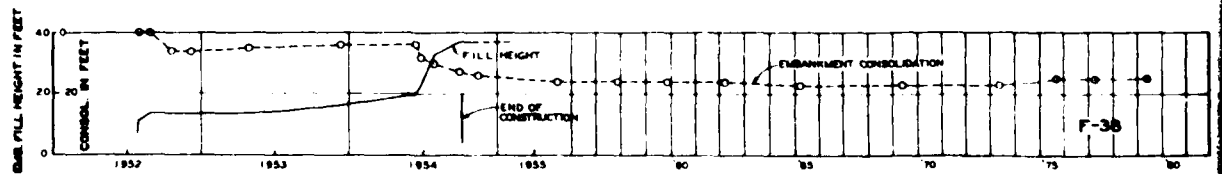
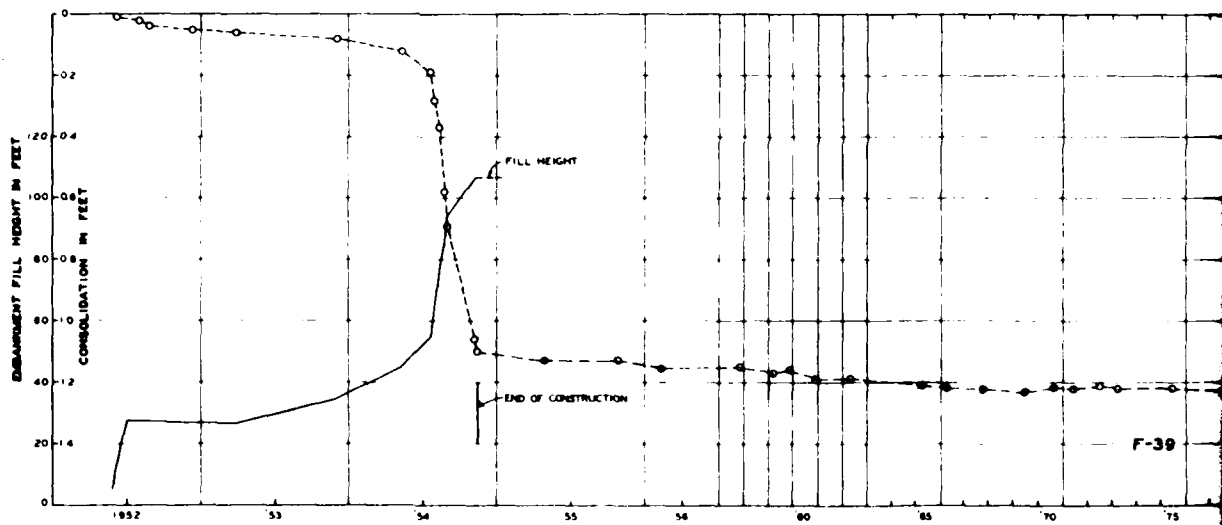
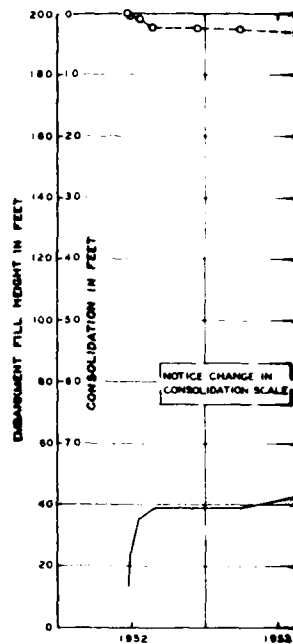
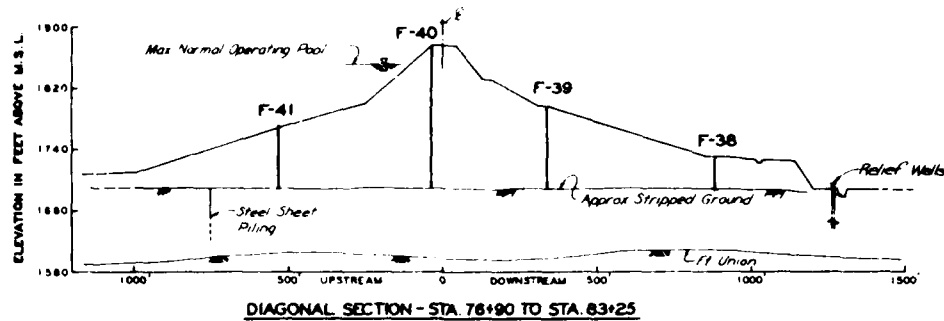
LEMENT DIAGONAL SECTION



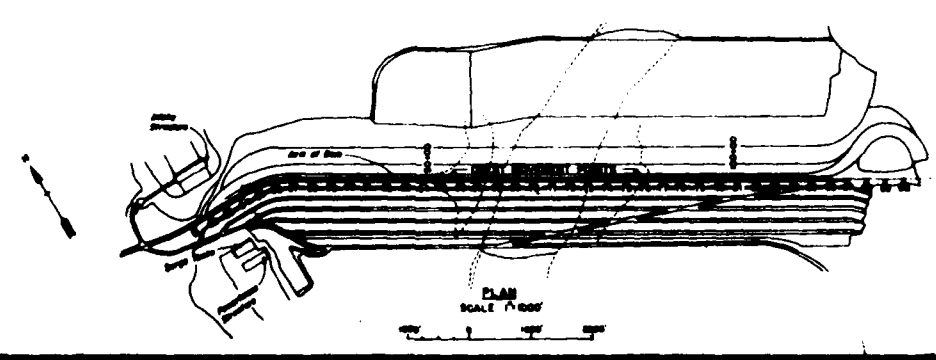
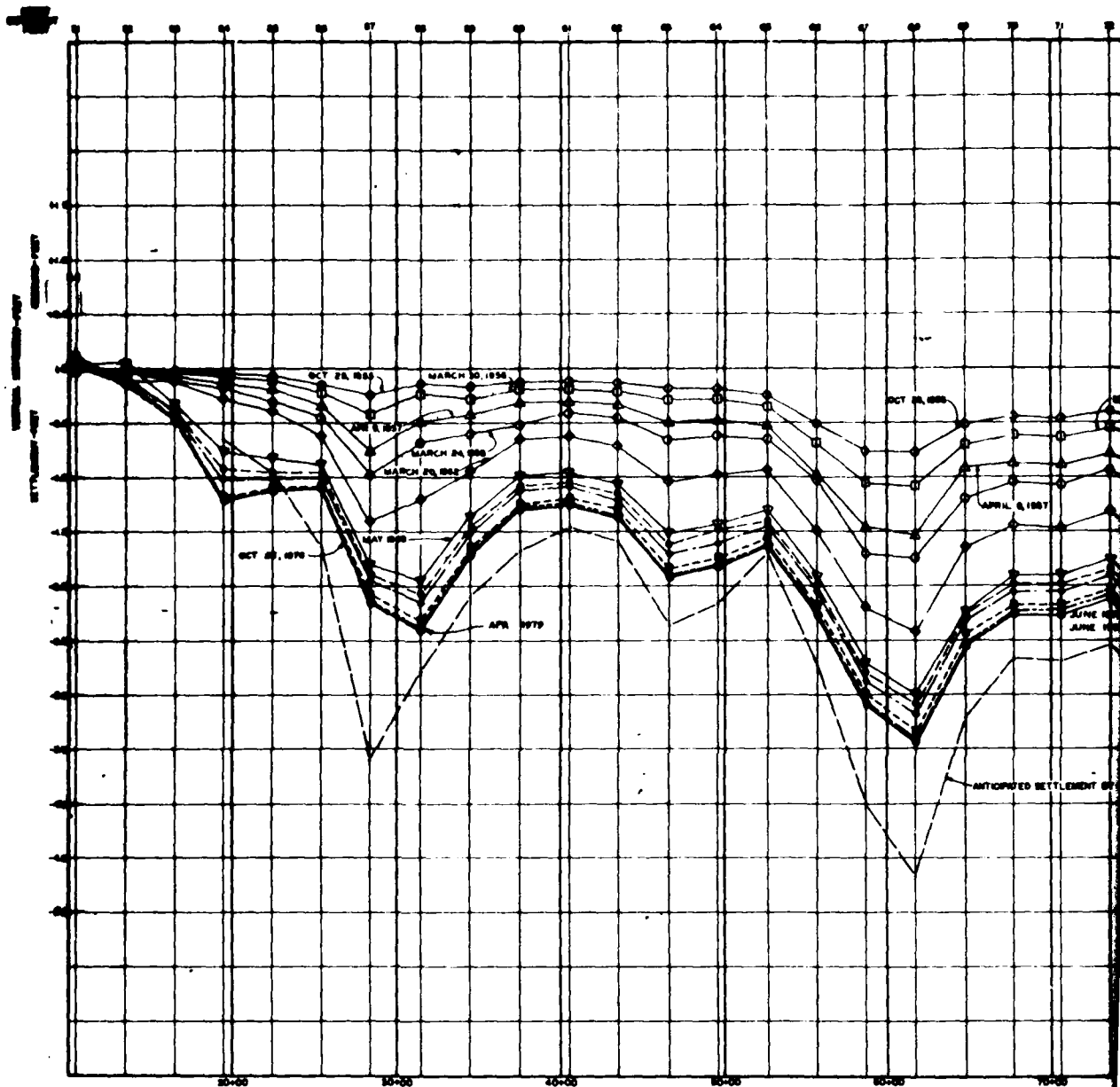
THIS DRAWING HAS BEEN REDUCED TO  
THREE-FIFTHS THE ORIGINAL SCALE

U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA	
MISSOURI RIVER GARRISON DAM - LAKE SAKAKAWEA SETTLEMENT AND CONSOLIDATION STUDIES	
FILL HEIGHT AND FOUNDATION SETTLEMENT DIAGRAM SECTION STA. 76+90 TO 83+25	
DESIGNED BY: J. A. J.	DATE: SEP 1975
DRAWN BY: J. A. J.	SCALE: AS SHOWN
CHECKED BY: J. A. J.	DATE: SEP 1975
APPROVED: <i>Russell F. Allen</i> CHIEF OF DISTRICT	

*J*



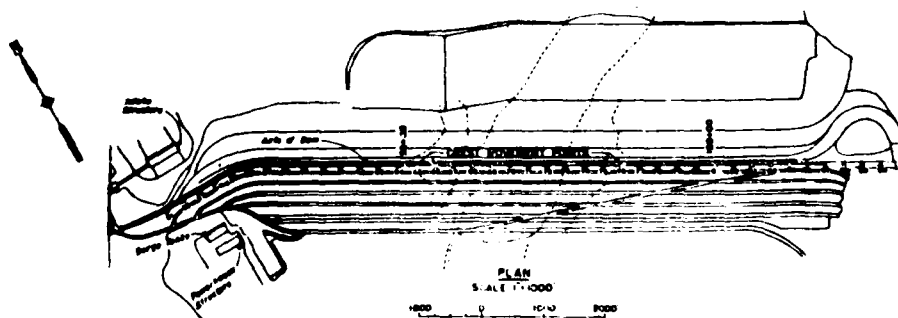
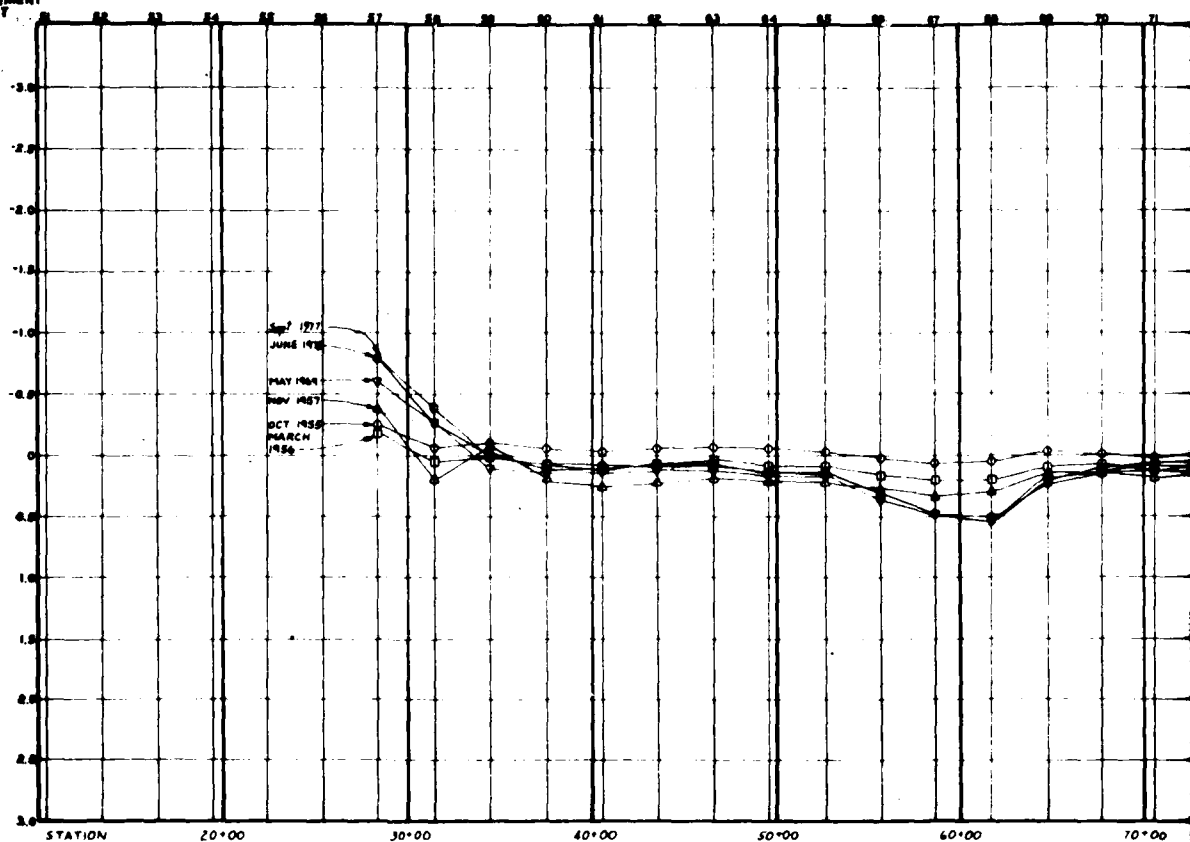


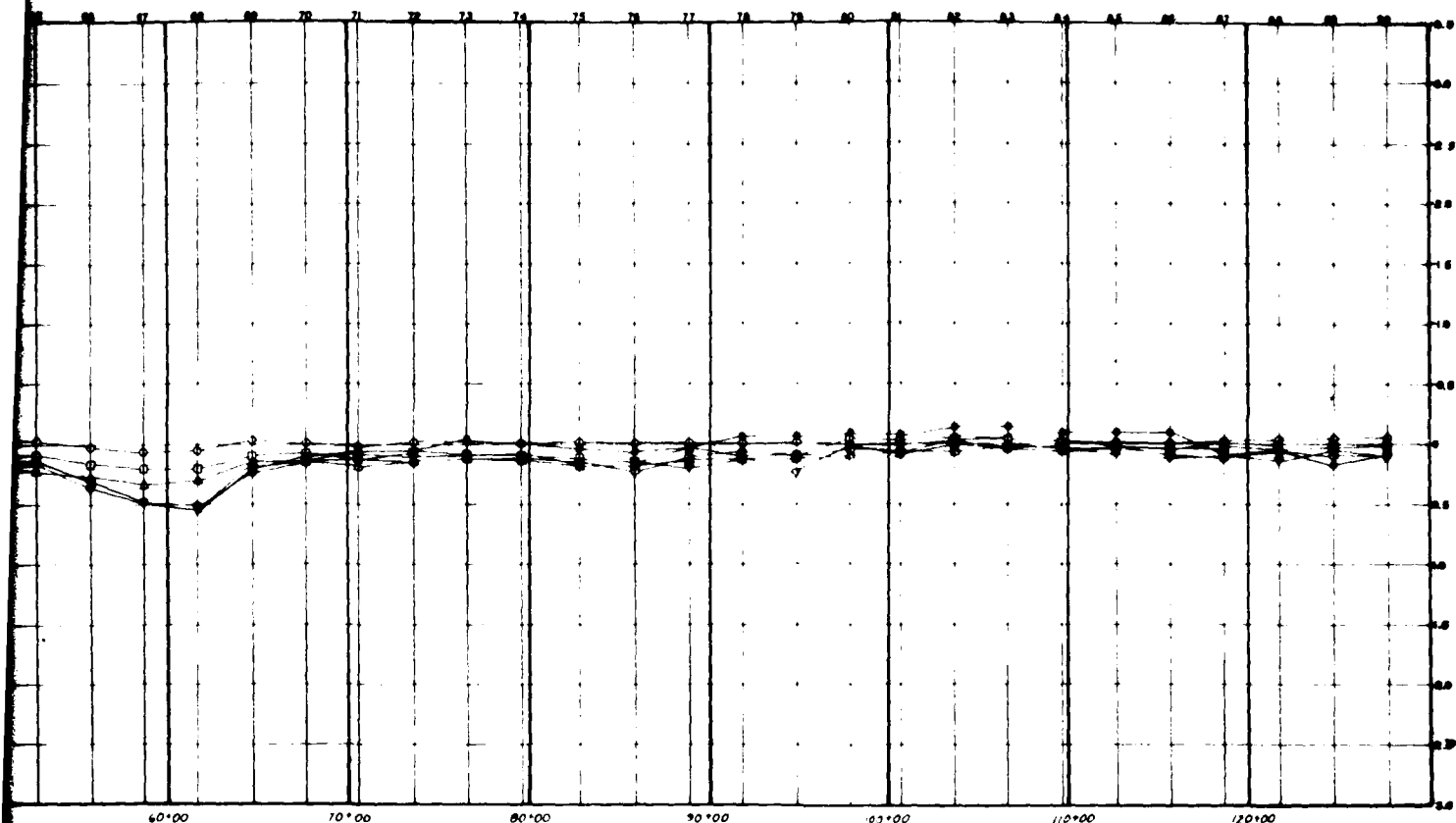




CREST  
MOVEMENT  
POINT

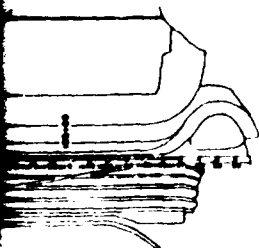
TRANSVERSE MAGNITUDE - FEET





**Notes**

1. Movement in a plus (+) direction indicates downstream movement
2. Movement in a negative (-) direction indicates upstream movement
3. The July 1979 survey closely resembles the Sept. 1977 survey



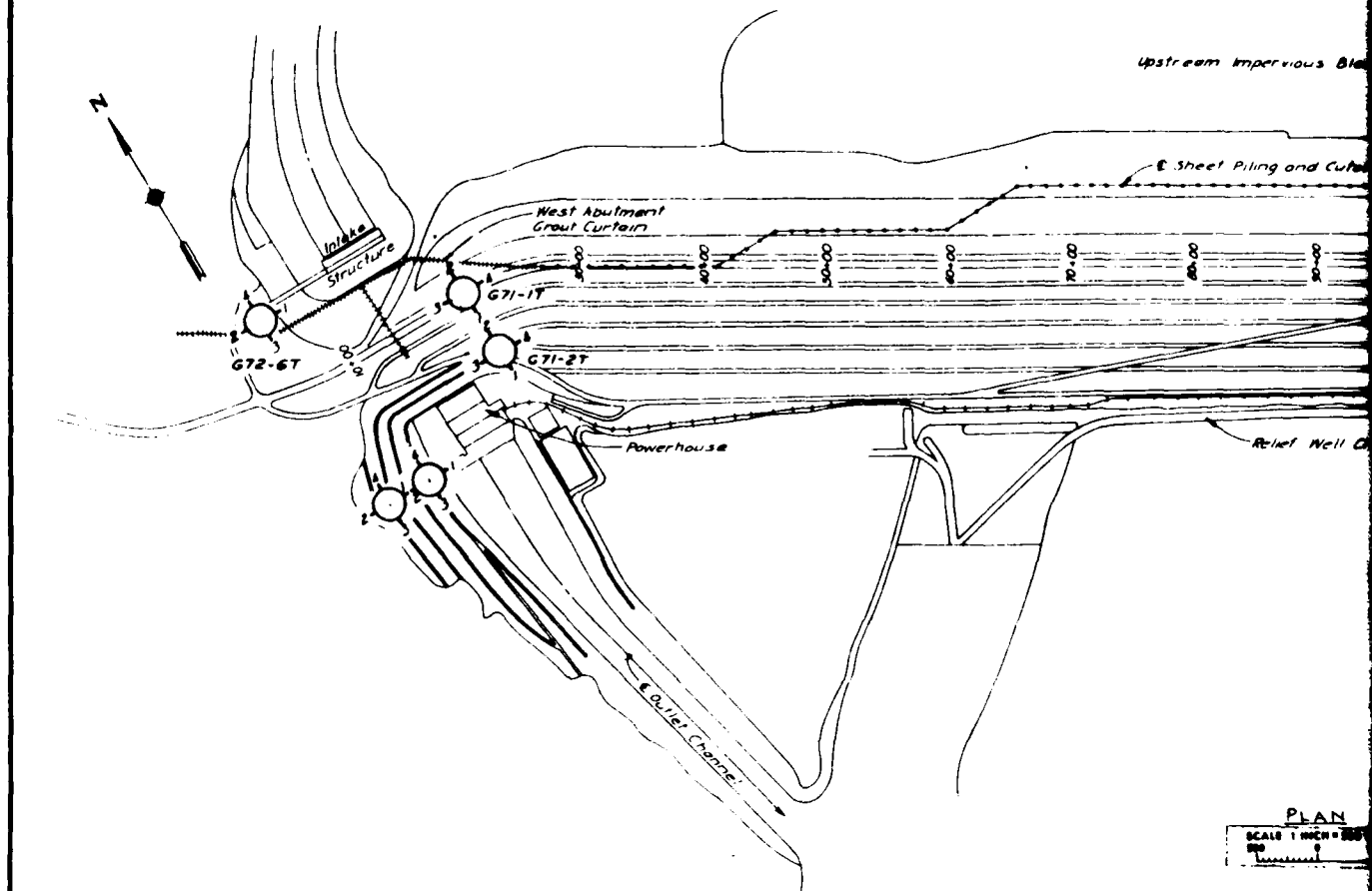
THIS PLAN APPROVED SEPTUARY 80.  
MODIFICATION NO.

REVISIONS	
NO.	DATE
U. S. ARMY ENGINEER DISTRICT, OMAHA GROUP OF ENGINEERS OMAHA, NEBRASKA	
MISSOURI RIVER GARRISON DAM AND RESEVOIR CREST MOVEMENT OBSERVATIONS TRANSVERSE MOVEMENT	
DESIGNED BY	DATE
CHECKED BY	DATE
APPROVED BY	DATE
PROJECT NO.	DATE
CONTRACT NO.	DATE
SECTION NO.	DATE

CONSTRUCTION FOUNDATION REPORT

(1987)

PLATE 135



Tiltmeter No.	Location	Sta	Range	Bottom Depth	Elev T.O.P.
G71-1T	Crest	20+00	30' U.S.	207.0	1875.8
G71-2T	Emb. Berm	20+09	320 D.S.	211.0	1759.6
G72-3T	PH Slope	161+30	8+10 R?	165.8	1793.4
G71-4T	PH Slope (Base)	161+30	4+85 R?	160.0	1693.8
G72-5T	Spillway	63+00	4+70 L?	161.6	1718.0
G72-6T	Intake Bridge			101.5	1763.4



Upstream Impervious Blanket

E Sheet Piling and Cutoff Trench

Spillway Crest

Relief Well Channel

Fault SF 1

G72-ST

PLAN

SCALE 1 INCH = 500 FEET

THIS DRAWING AND DATA REFERRED TO  
HEREIN IS NOT TO BE USED FOR ANY OTHER PURPOSE

Sta	Range	Bottom Depth	Elev T.O.P.
20+00	30' U.S.	207.0	1875.8
20+09	520 D.S.	211.0	1759.6
161+30	8+10 Rf	165.8	1793.4
161+30	4+85 Rf	160.0	1693.8
63+00	4+70 Lf	161.6	1718.0
		101.5	1765.4



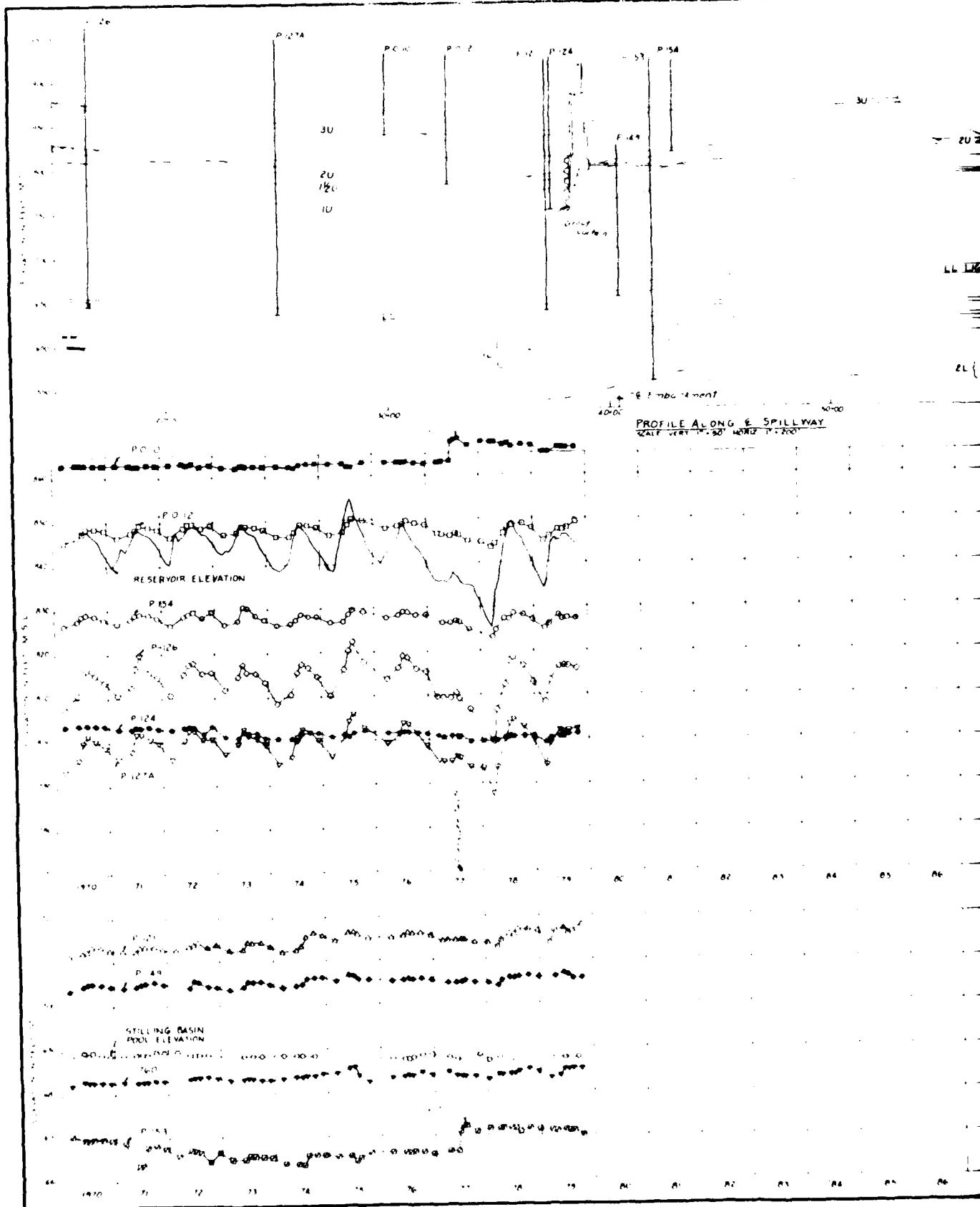
DATE	DESCRIPTION	DATE	APPROVED
REVISIONS			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
DESIGNED BY		MISSOURI RIVER	
CHECKED BY		GARRISON DAM AND RESERVOIR	
REVIEWED BY		SLOPE INDICATORS	
APPROVED BY		LOCATION PLAN	
DATE		DATE	
SCALE AS SHOWN		SCALE AS SHOWN	

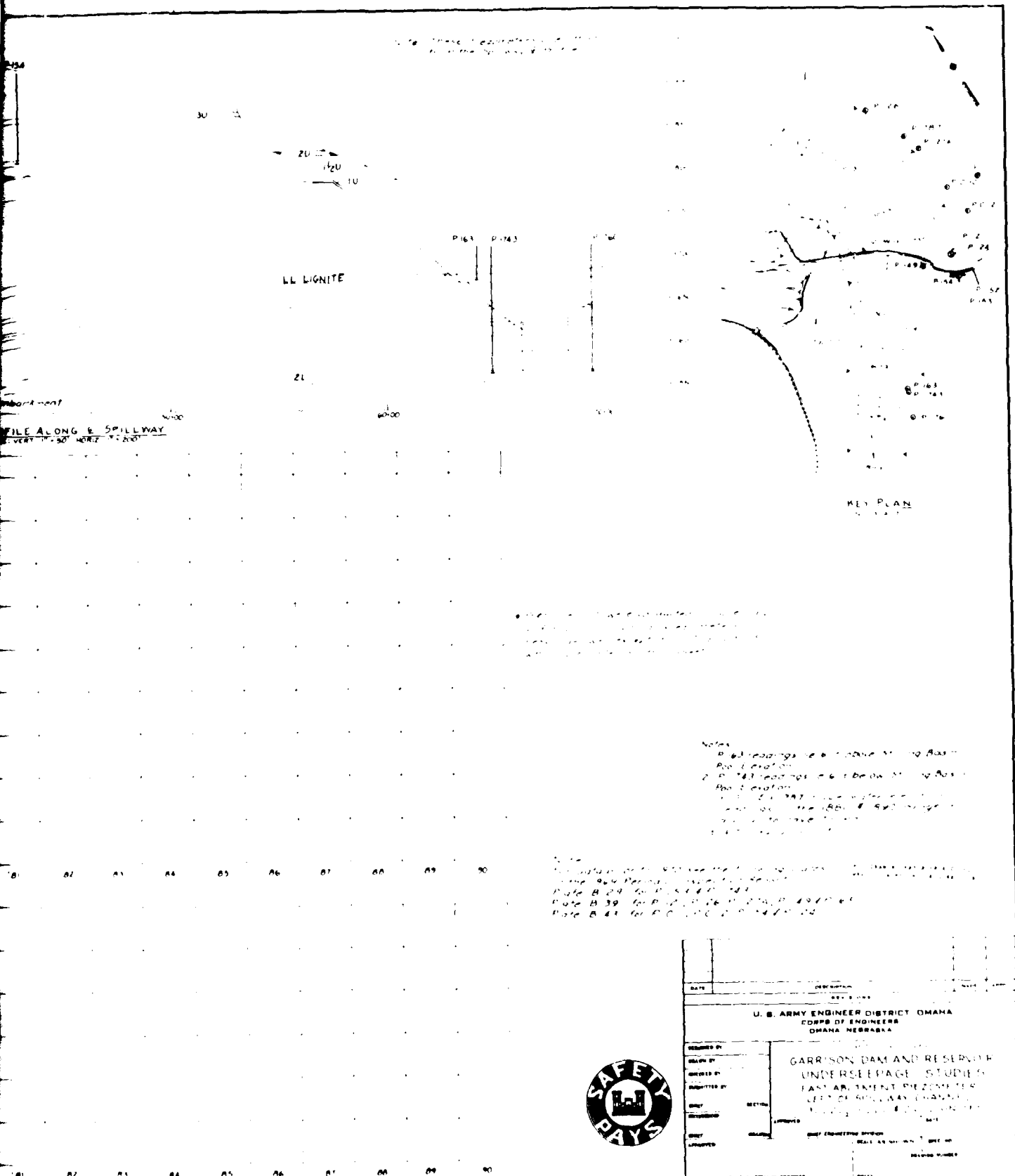
THIS PLAN ACCOMPANIES CONTRACT NO. \_\_\_\_\_  
MODIFICATION NO. \_\_\_\_\_

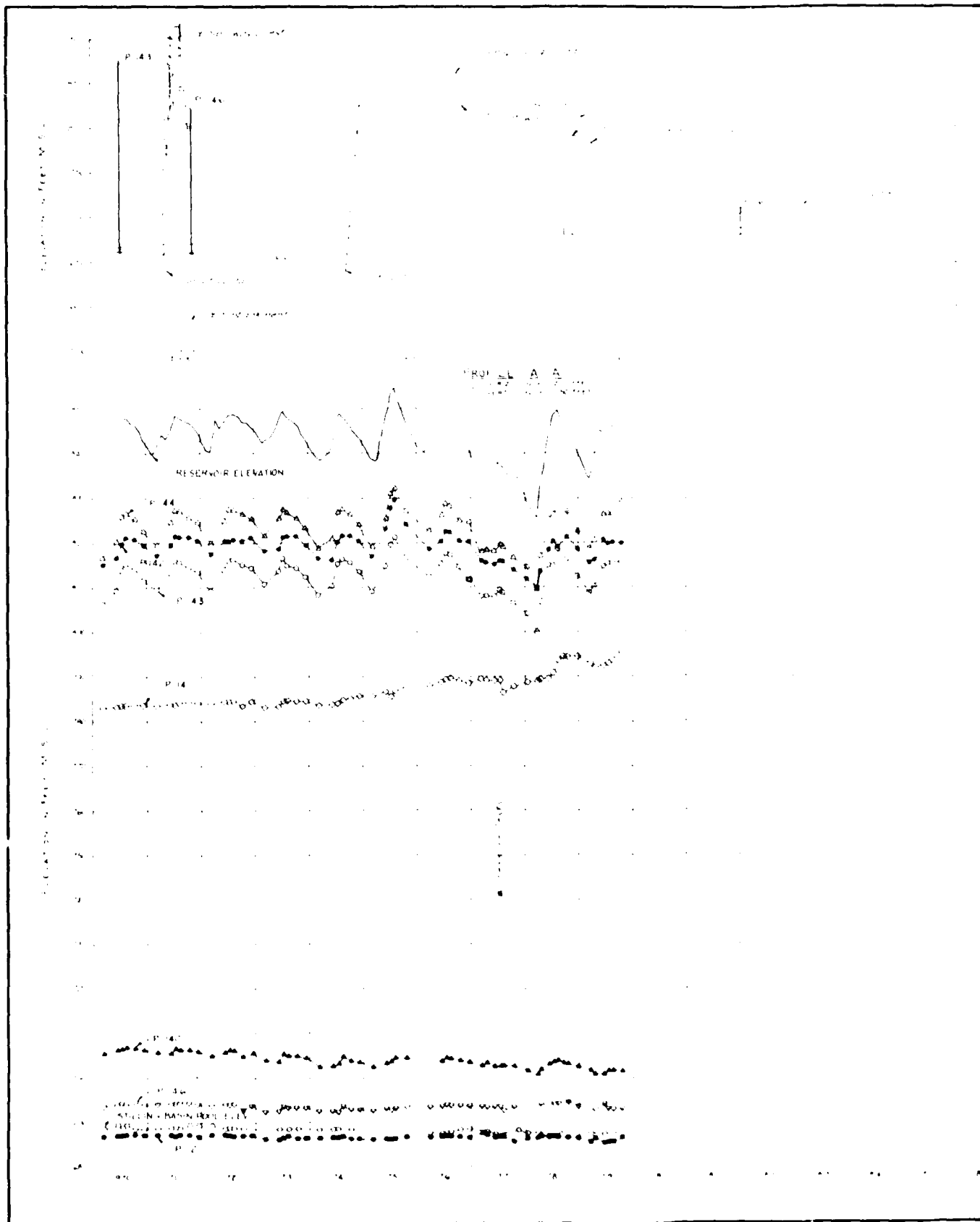
CONSTRUCTION FOUNDATION REPORT

(1982)

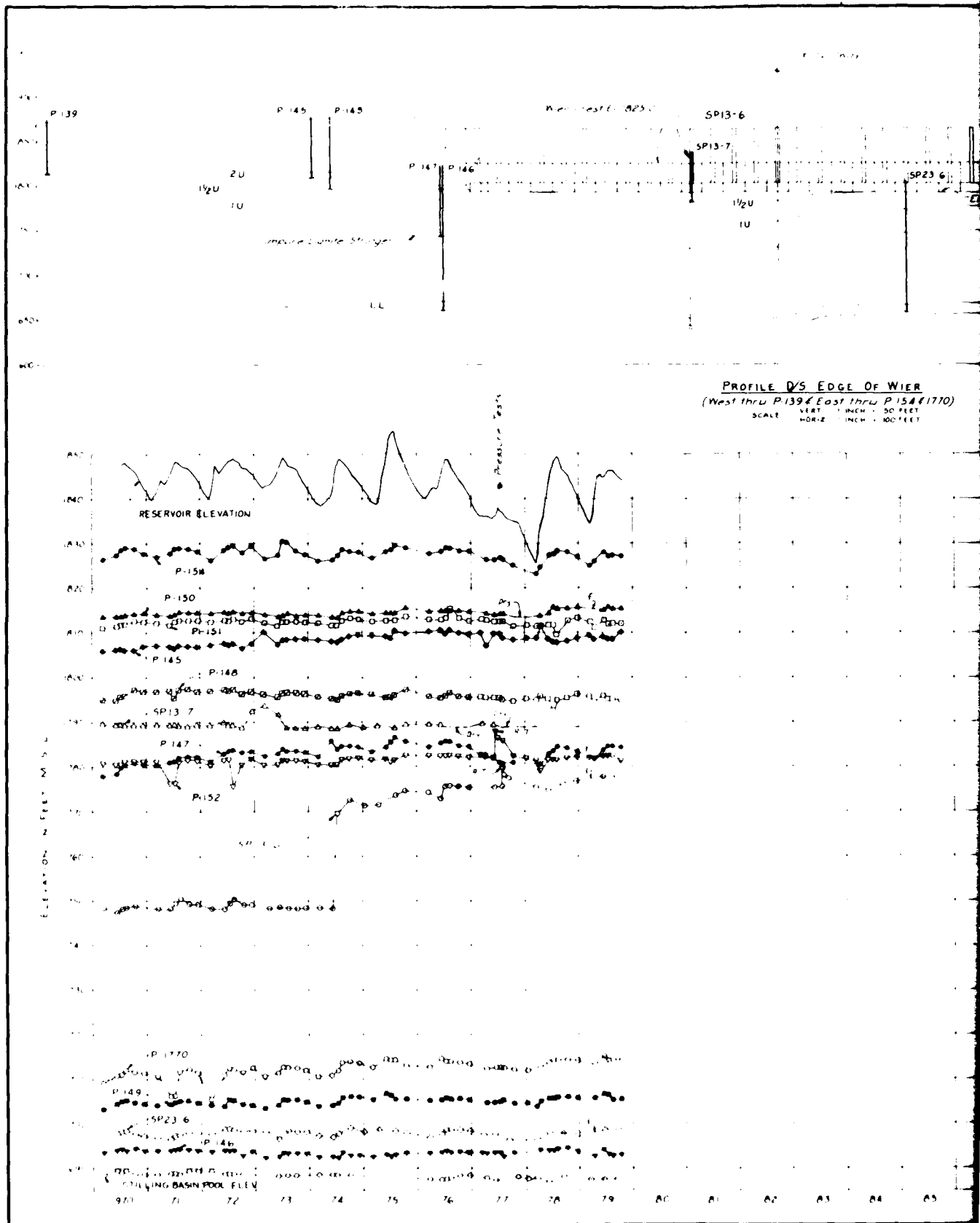
PLATE 136

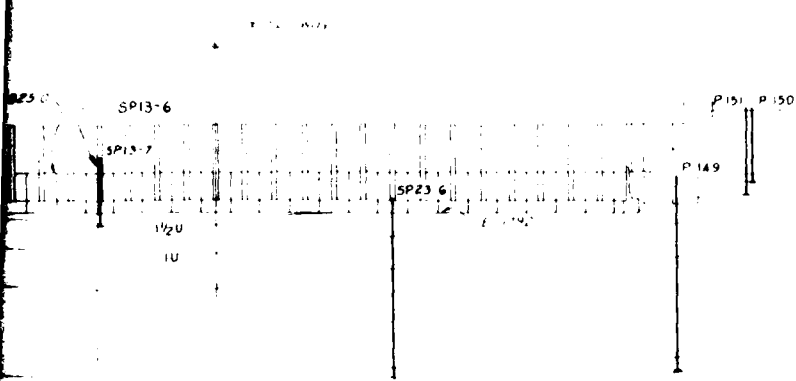




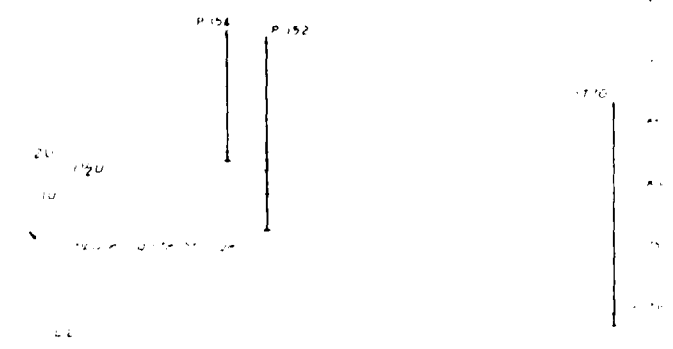








PROFILE VS EDGE OF WIER  
 (West thru P139 East thru P154/1770)  
 SCALE: VERT. 1 INCH = 30 FEET  
 HORIZ. 1 INCH = 100 FEET



KEY PLAN  
 NO SCALE

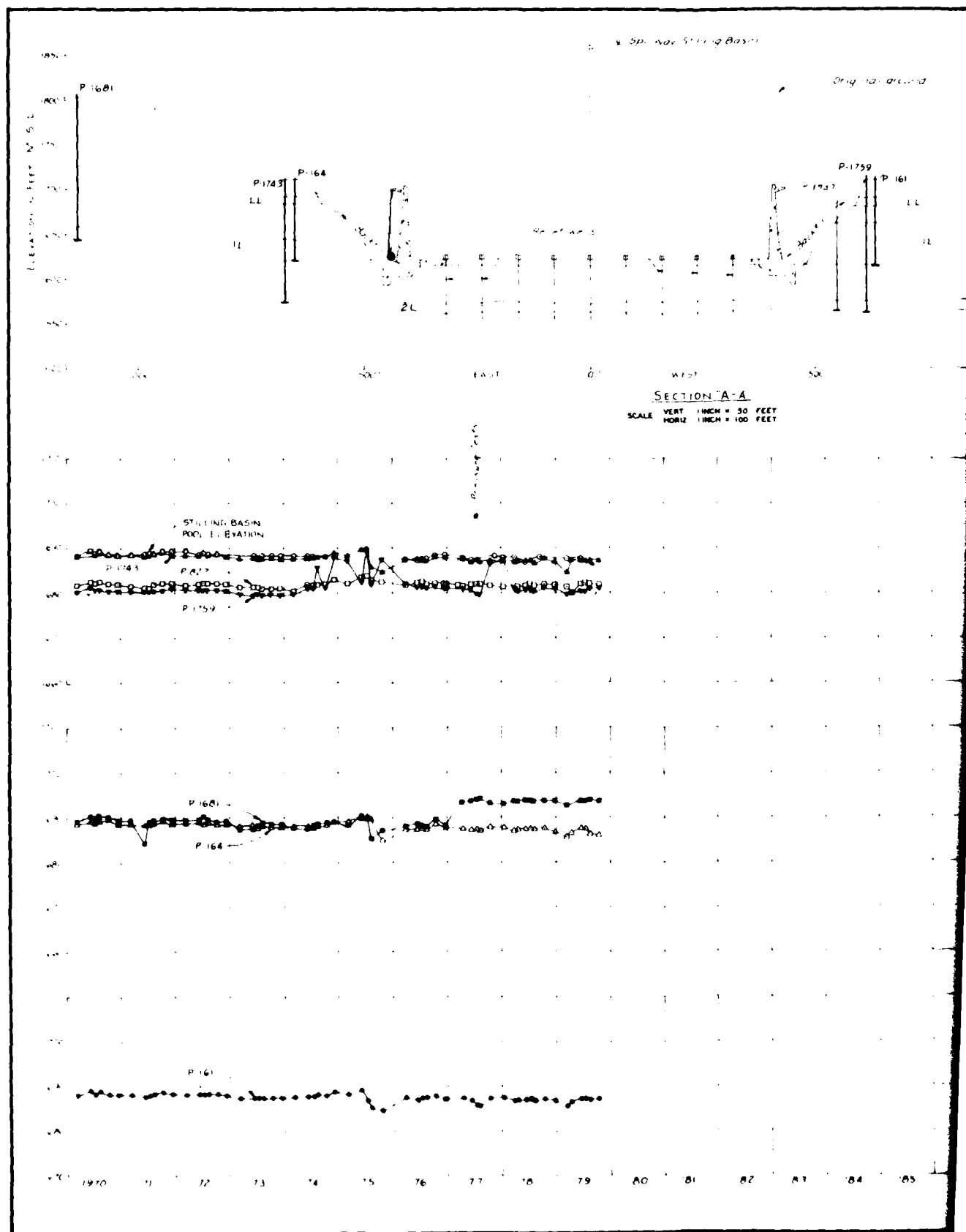
Note:  
 For data from P139 see the following plates:  
 Plate B 37 for P148  
 Plate B 39 for P149, SP23-6  
 Plate B 41 for SP23-7  
 Plate B 43 for P150, P151, P152  
 Plate B 45 for P154, P155, P156

Pressure tests were conducted for  
 1000 psi and 4000 psi at all  
 piezometers.  
 The tests were conducted in  
 accordance with the  
 specifications of the  
 Corps of Engineers.  
 The results of the tests  
 are shown in the  
 following plates.



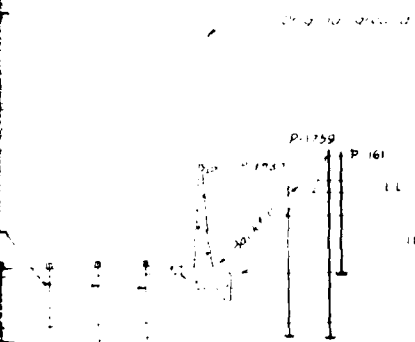
DATE		DESCRIPTION		MADE	APPROVED
REVISIONS					
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA					
DESIGNED BY		CHECKED BY		DRAWN BY	
GARRISON DAM AND RESERVOIR		EAST ABUTMENT PIEZOMETERS		PIEZOMETERS ACROSS SPILLWAY CREST	
20, 120 & 140 LIGNITE & LIGNITE STRINGER		DATE		SCALE AS SHOWN	
APPROVED		CHIEF ENGINEERING OFFICER		DATE	
U. S. E. DISTRICT ENGINEER		CHIEF		DRAWING NUMBER	

2

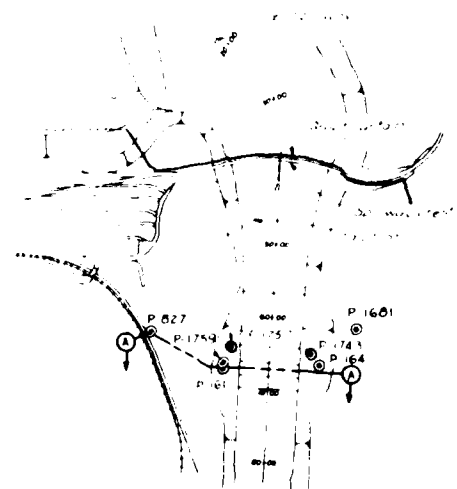
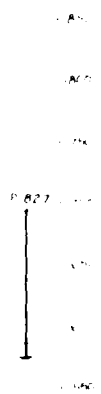




Spillway section diagram



SECTION A-A  
SCALE VERT. 1 INCH = 50 FEET  
HORIZ. 1 INCH = 100 FEET



KEY PLAN  
NO SCALE

THIS DRAWING HAS BEEN REJECTED TO  
BE REJECTED TO THE U.S. ARMY DISTRICT

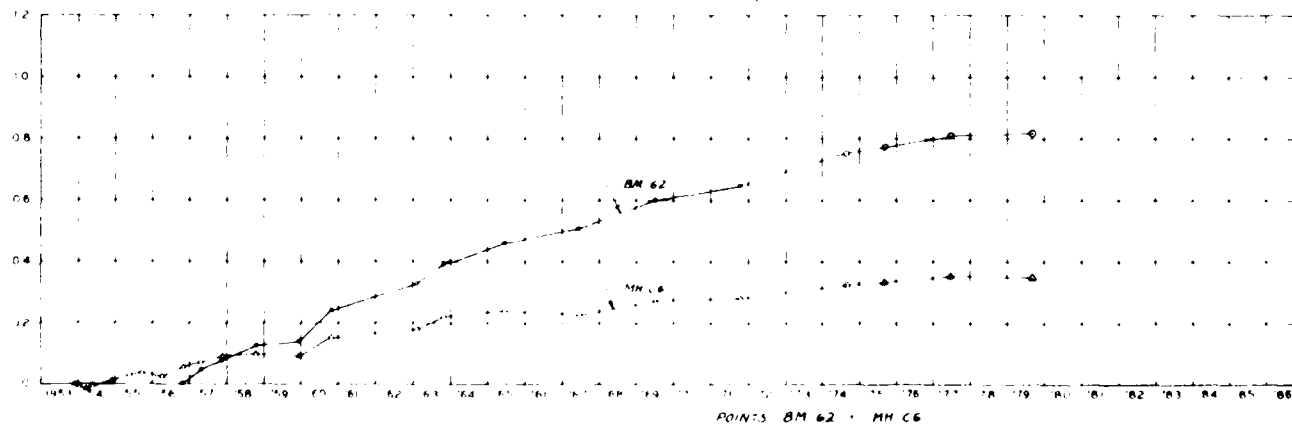
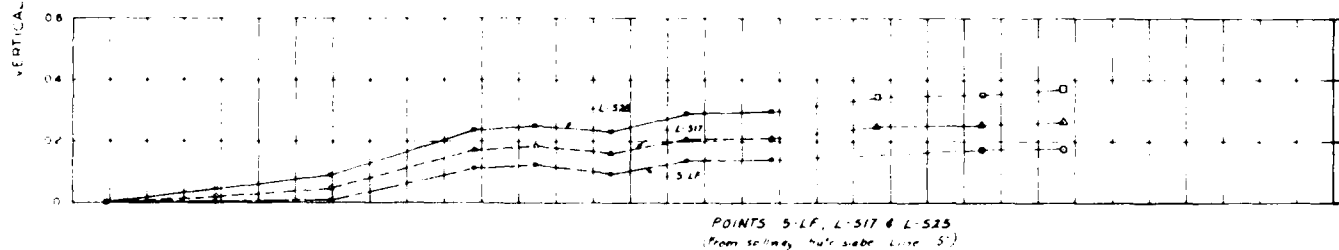
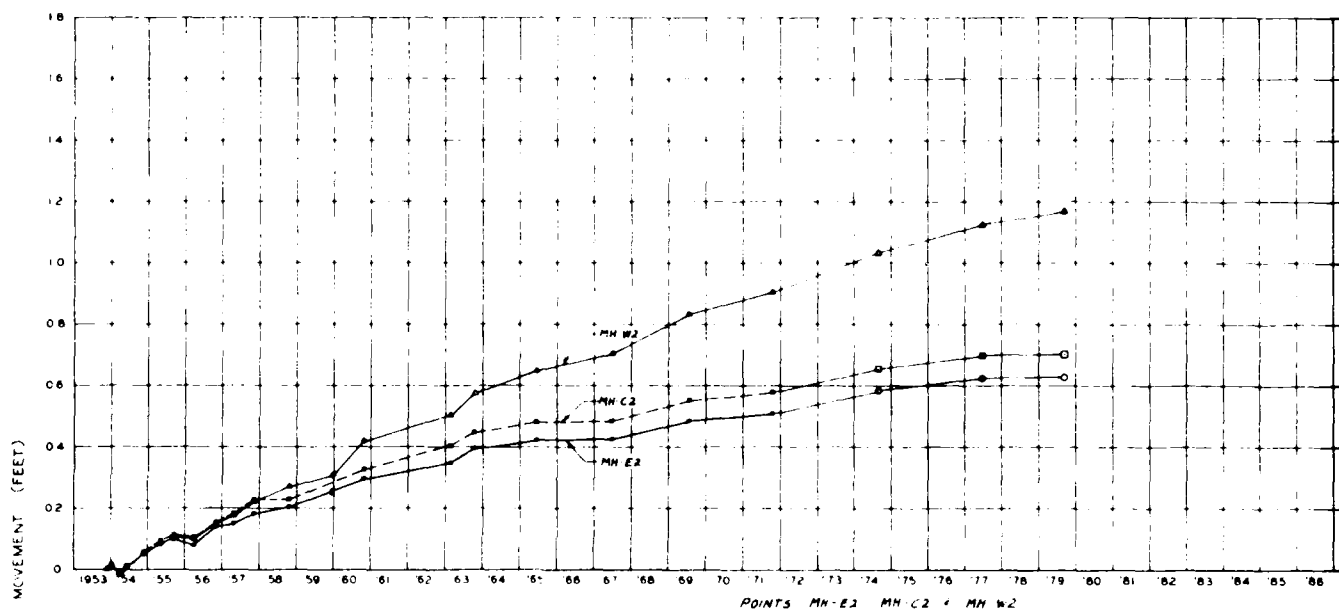
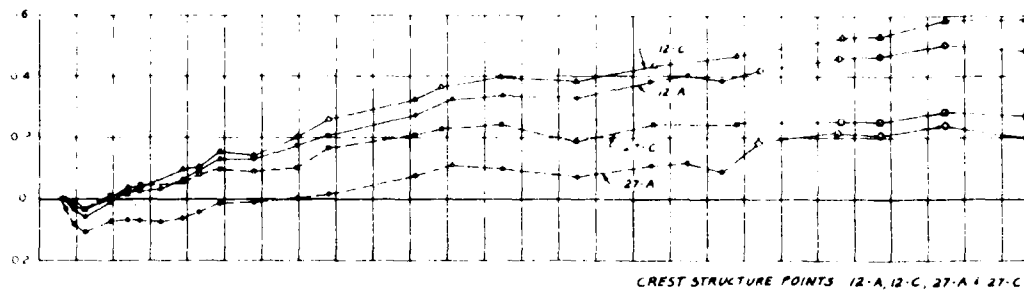
Note  
For data prior to 1970 see the following plates  
in the 1969-1970 Inspection Report  
Plate B-27 for P-827 & P-1759  
Plate B-29 for P-161  
Plate B-33 for P-164 & P-165

• Drawings of the dam and reservoir  
are shown in the Appendix  
to the Inspection Report

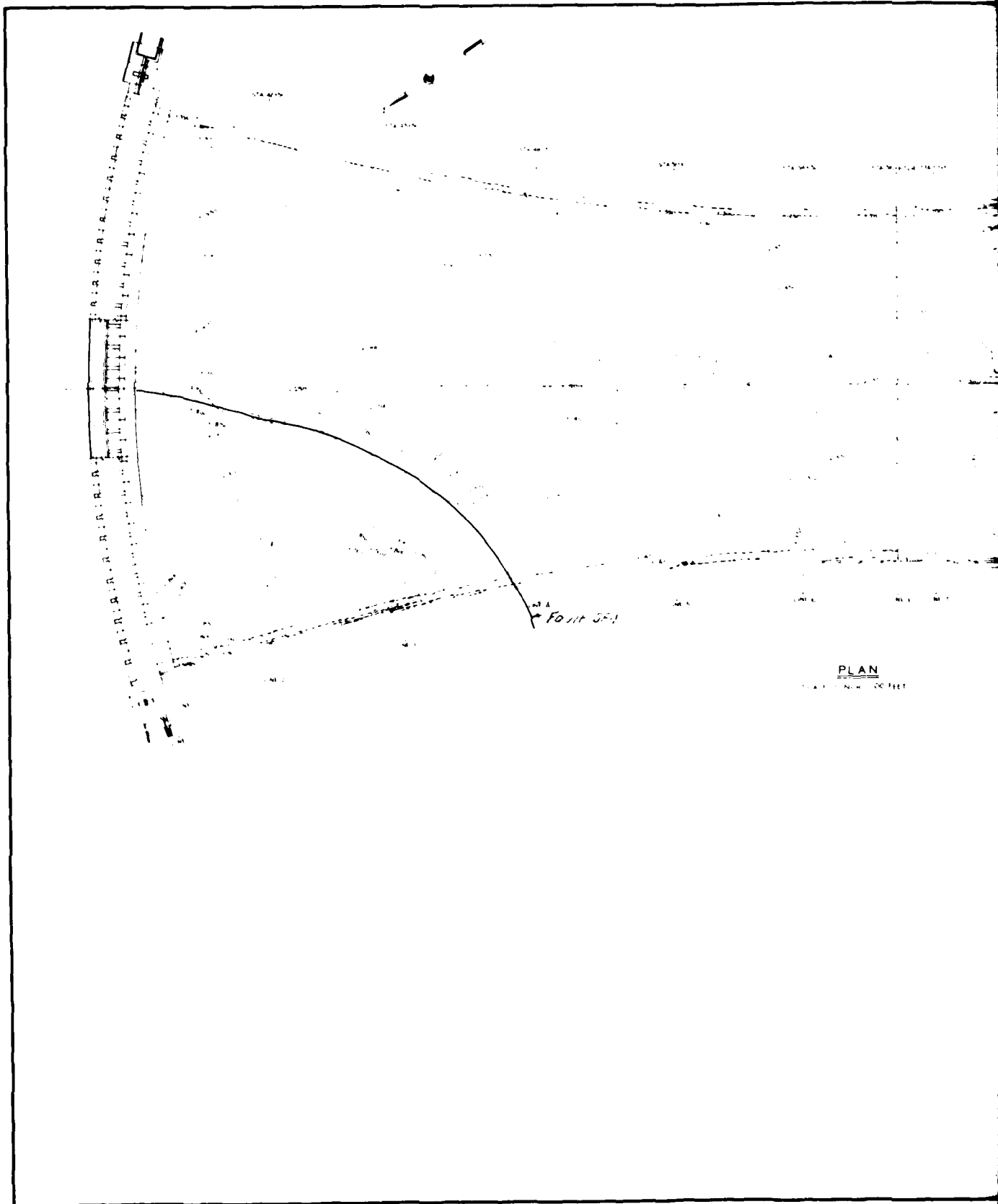


DATE	DESCRIPTION	SCALE
	REVISION ONE	
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA		
DESIGNED BY	CHECKED BY	
DRAWN BY	APPROVED BY	
ENGINEERED BY		
DATE	REVISION	
DATE	REVISION	
DATE	REVISION	
GARRISON DAM AND RESERVOIR UNDERSEEPAGE STUDIES EAST ABUTMENT STILLING BASIN PIEZOMETERS ILLUMINATED		
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA		

THIS PLAN ACCOMPANIES CONTRACT NO.  
MODIFICATION NO.







PLAN

SCALE 1" = 100' FEET

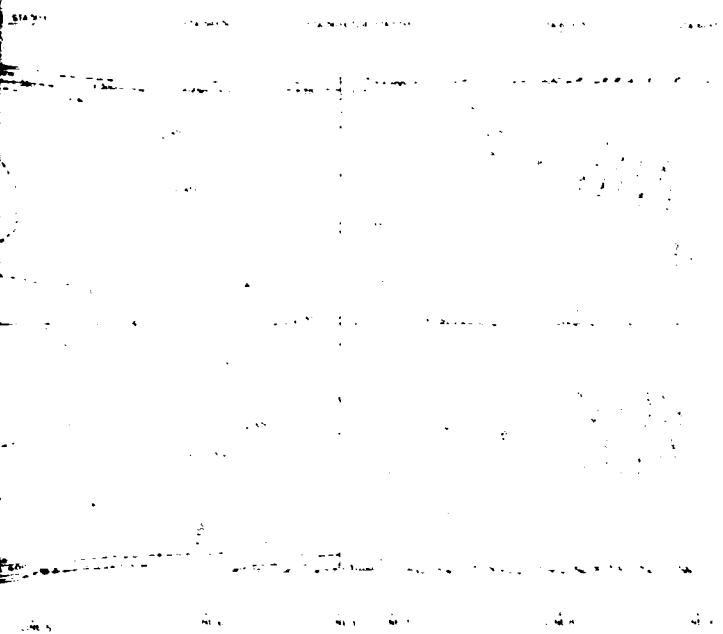
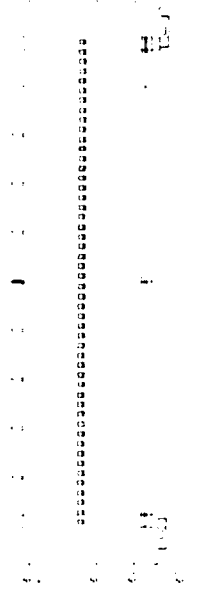


FIGURE 1. PLAN VIEW OF CHANNEL SLAB



LEGEND

1977

PLAN

AS SHOWN ON SHEET

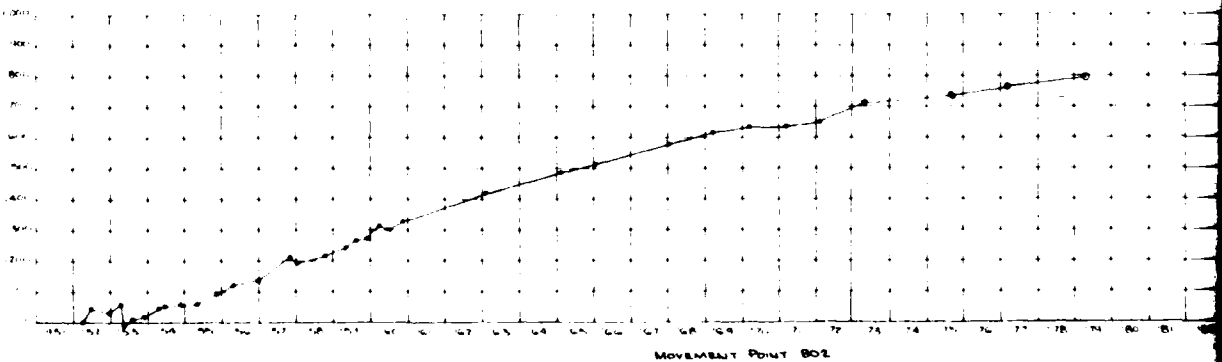
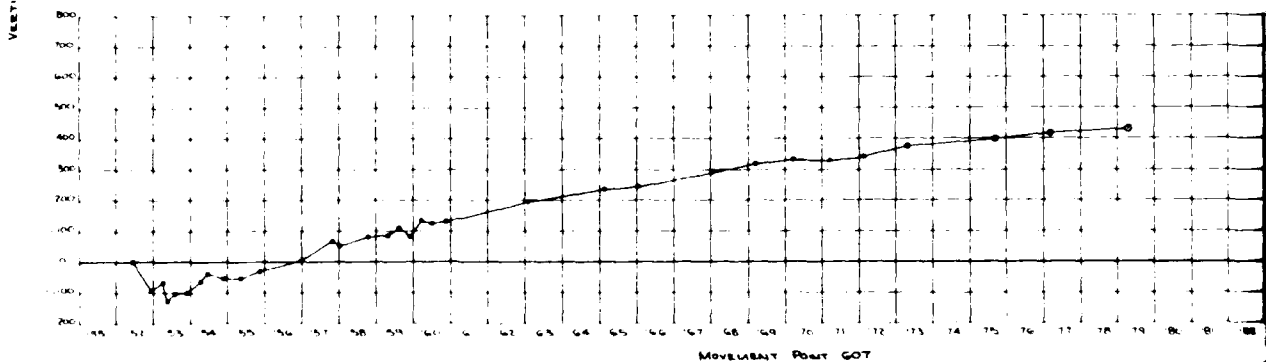
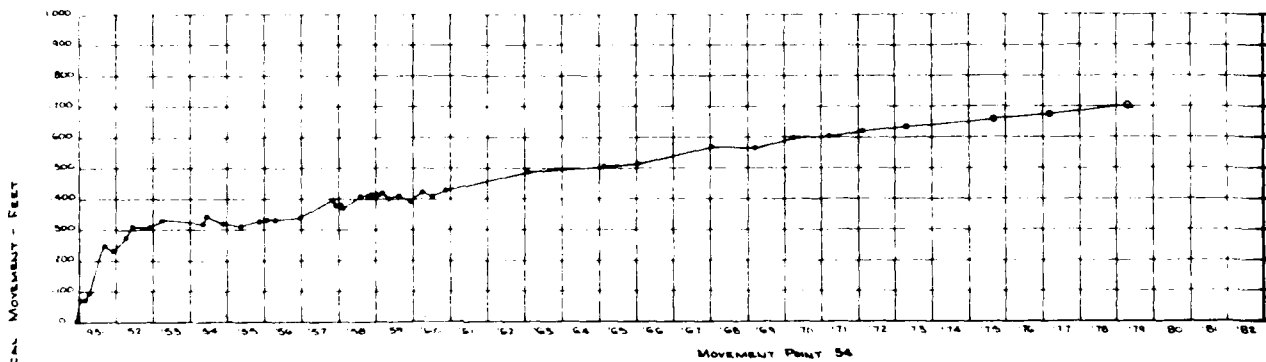
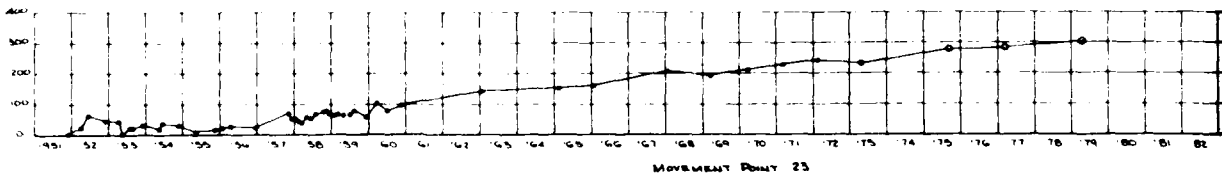
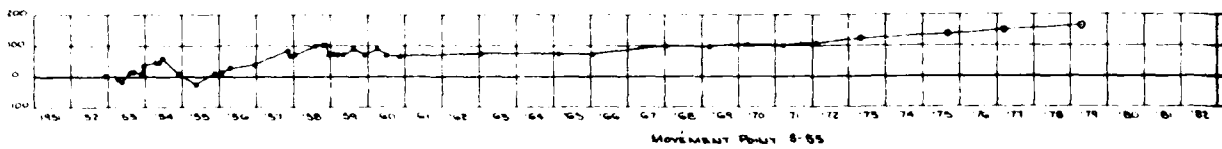
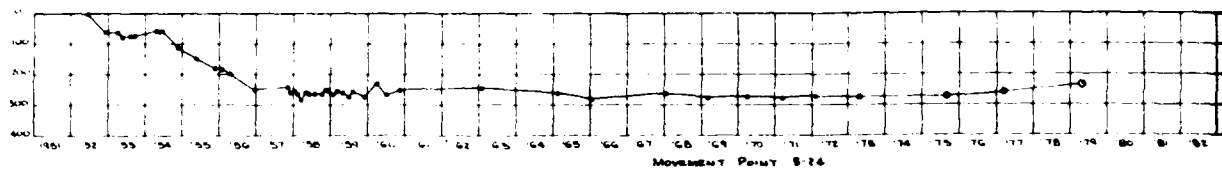
The plan view of the channel slab is shown in Figure 1. The plan view shows the channel slab is 10 feet wide and 15 feet long. The channel slab is located in the center of the site. The channel slab is shown in the plan view of the channel slab.

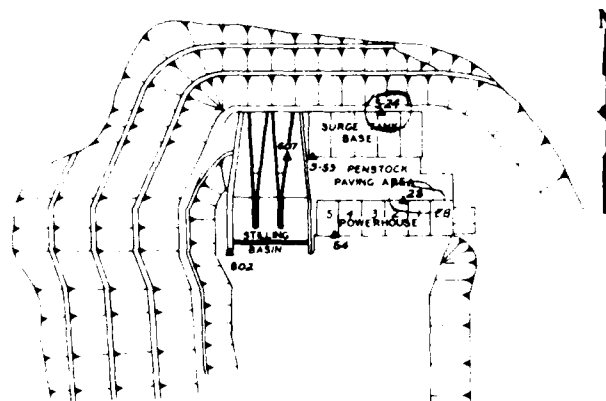
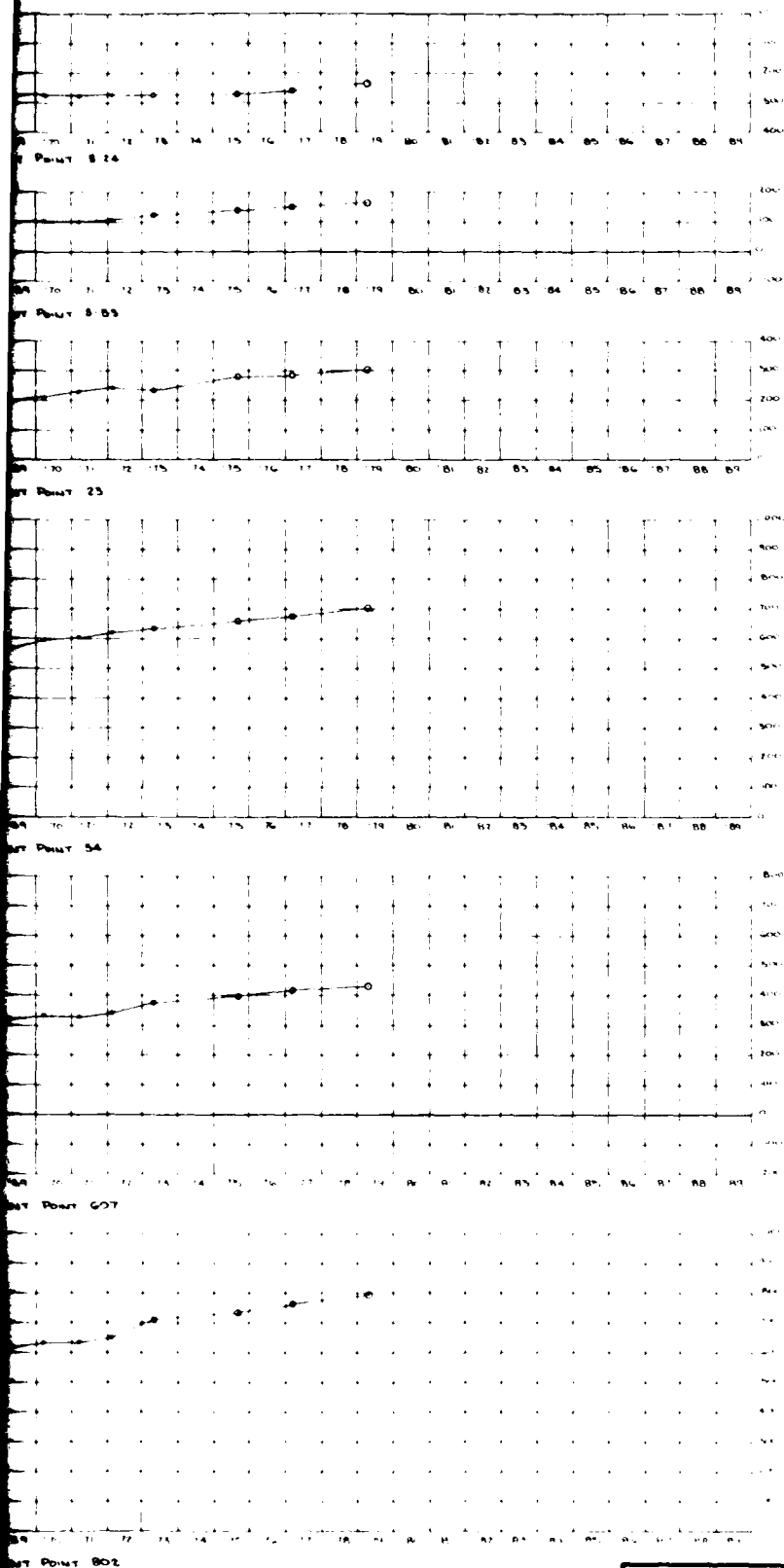
1. The plan view of the channel slab is shown in Figure 1. The plan view shows the channel slab is 10 feet wide and 15 feet long. The channel slab is located in the center of the site. The channel slab is shown in the plan view of the channel slab.



THIS PLAN ACCOMPANIES CONTRACT NO. DACA 48-7 CO. MODIFICATION NO.

U. S. ARMY ENGINEER DISTRICT OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA	
REPORTED BY:	MARK R. DAN, LAKE SAKAKAWEA
DESIGNED BY:	SPIELWAY MOVEMENT STUDIES
CHECKED BY:	REBOUND CONTOURS CHANNEL SLAB
SUBMITTED BY:	
DATE:	
APPROVED:	





KEY PLAN

THIS DRAWING HAS BEEN REDUCED TO  
THREE EIGHTS THE ORIGINAL SCALE

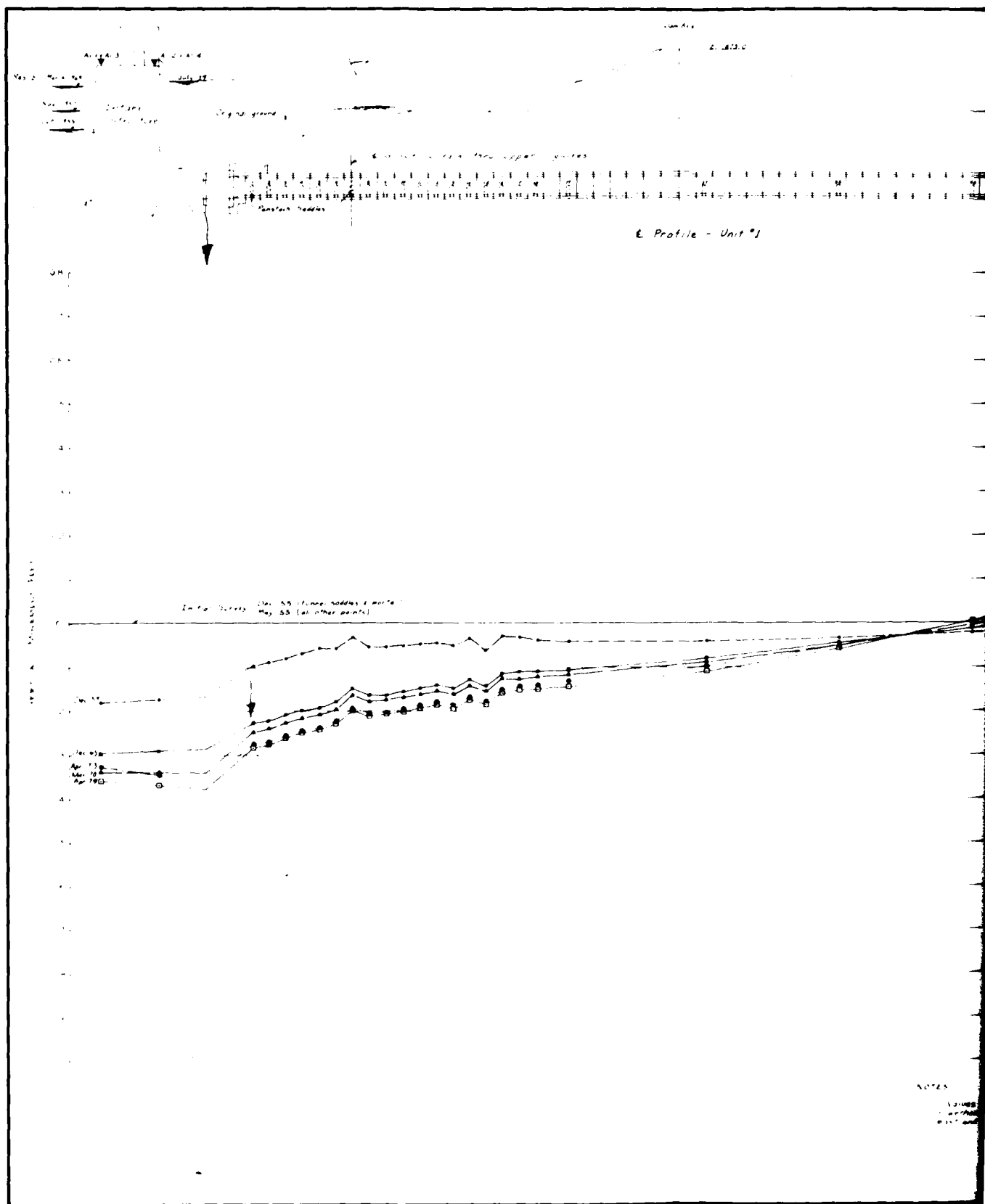


DATE	DESCRIPTION	DATE	APPROVED
REVISIONS			
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
DESIGNED BY	CHECKED BY		
DRAWN BY	PROJECT NO.		
REPORTED BY	VERTICAL MOVEMENT		
LAB	SECTION	TYPICAL MOVEMENT, EXIST. FOUNDATION	
APPROVED	DATE	DATE	
DATE	SCALE	DATE	DATE
APPROVED	DATE	DATE	DATE

THIS PLAN ACCOMPANIES CONTRACT NO.  
MODIFICATION NO.

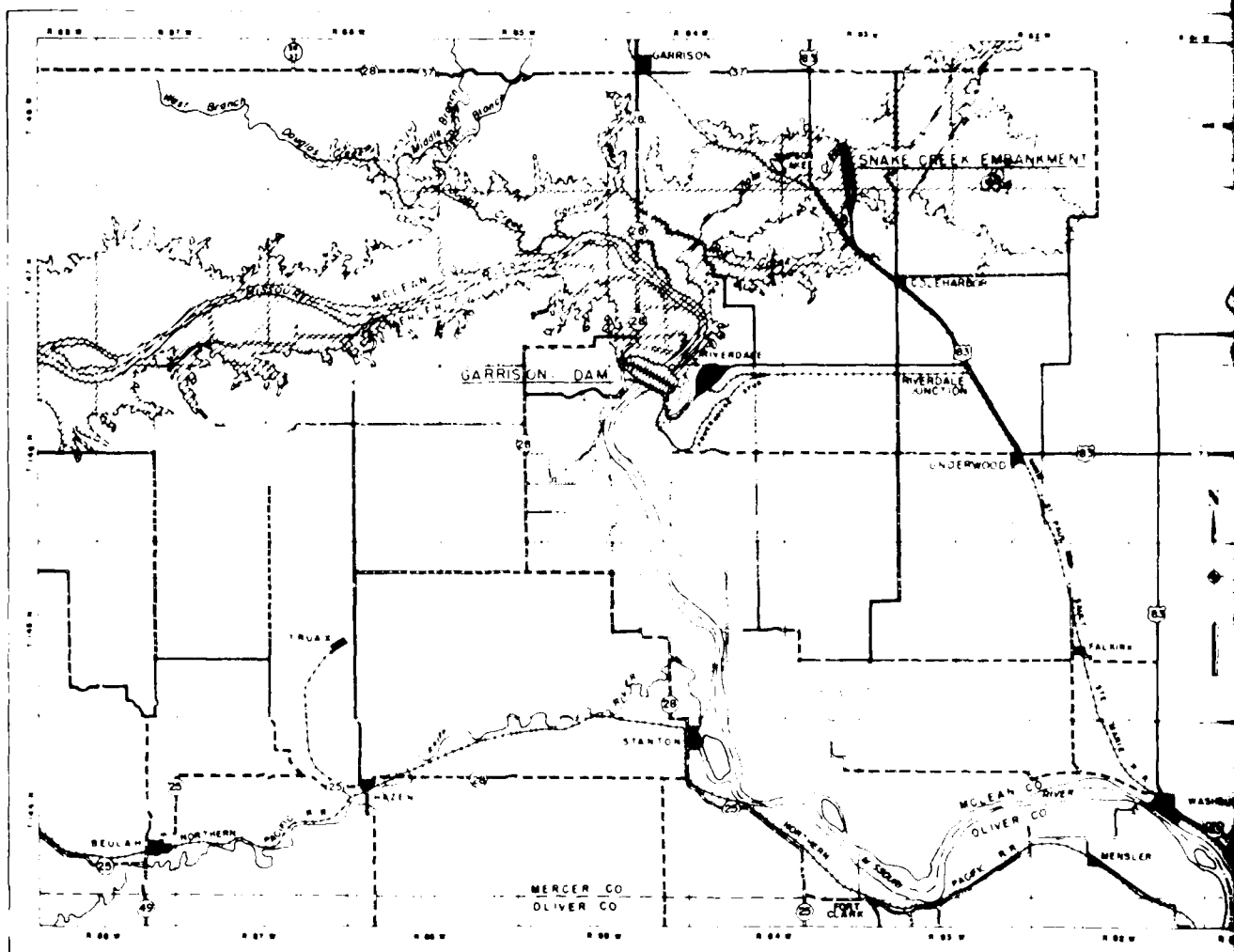
(1982)

PLATE 143

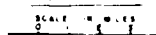








VICINITY MAP



# INDEX TO DRAWINGS

PROJECT LOCATION AND INDEX			
2	GENERAL PLAN - SHEET NO. 1	GR 21-1/1	14
3	GENERAL PLAN - SHEET NO. 2	GR 21-2/1	15
		GR 21-2/2	16
4	MAIN EMBANKMENT - PLAN AND PROFILE - SHEET NO. 1	GR 21-7/1	17
5	MAIN EMBANKMENT - PLAN AND PROFILE - SHEET NO. 2	GR 21-7/2	18
6	MAIN EMBANKMENT - PLAN AND PROFILE - SHEET NO. 3	GR 21-7/3	18A
7	MAIN EMBANKMENT - SECTIONS	GR 21-7/4	19
8	MAIN EMBANKMENT - DETAILS	GR 21-7/5	20
9	MAIN EMBANKMENT - HIGHWAY DRAINAGE STRUCTURES	GR 21-7/6	21
10	EXCAVATION - FUTURE PUMPING CHANNEL - PLAN	GR 21-8/1	22
11	EXCAVATION - REGULATING CONDUIT - PLAN AND PROFILE	GR 21-8/2	23
12	EXCAVATION - REGULATING CONDUIT - SECTIONS - SHEET NO. 1	GR 21-8/3	24
13	EXCAVATION - REGULATING CONDUIT - SECTIONS - SHEET NO. 2	GR 21-8/4	25
			26
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AD-A140 035

CONSTRUCTION FOUNDATION REPORT MISSOURI RIVER GARRISON  
DAM LAKE SAKAKAWEA VOLUME 2 DRAWINGS(U) ARMY ENGINEER  
DISTRICT OMAHA NE NOV 83

44

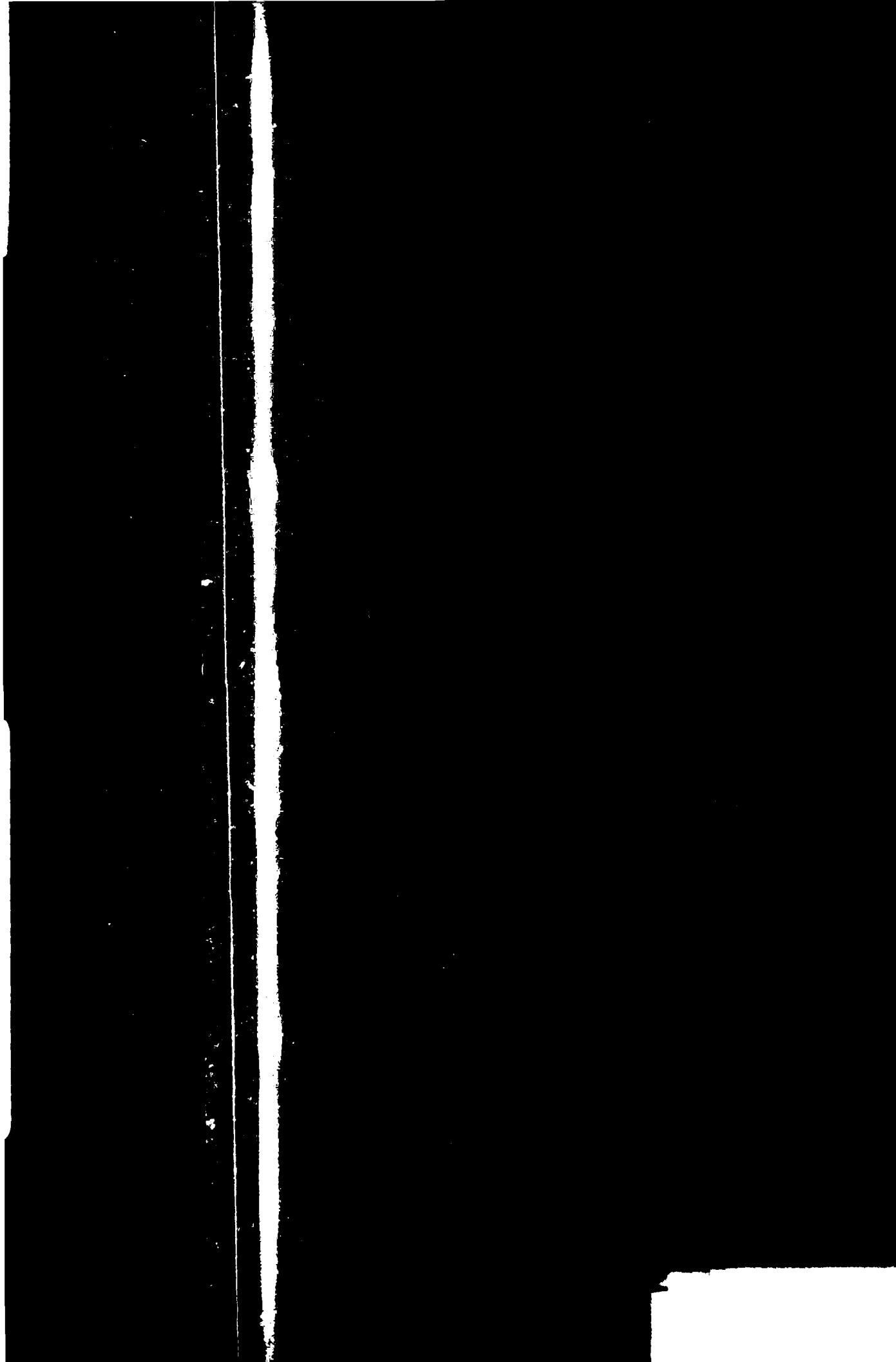
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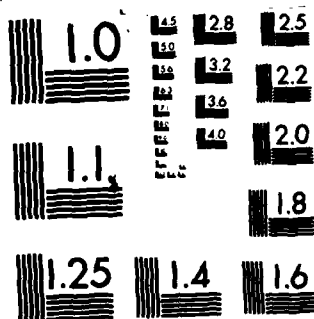
F/G 13/13

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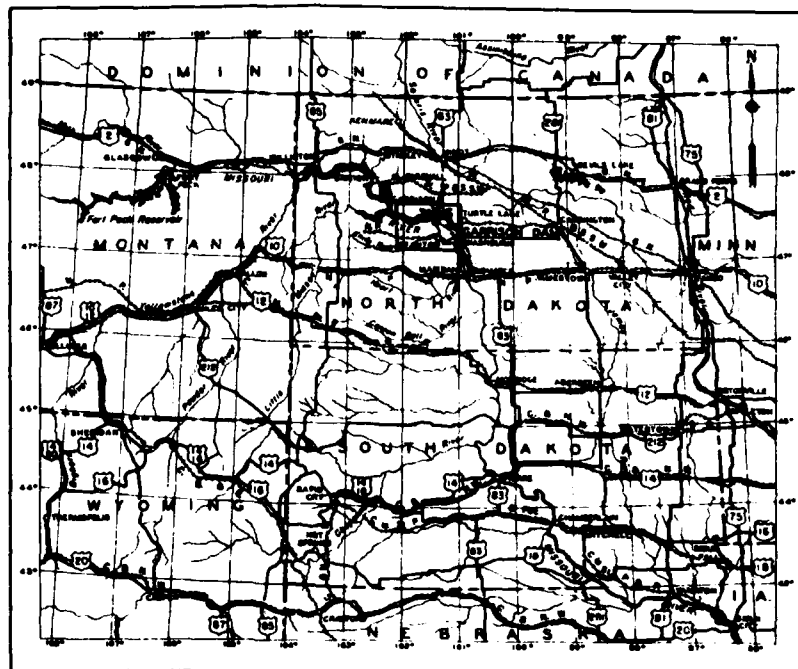
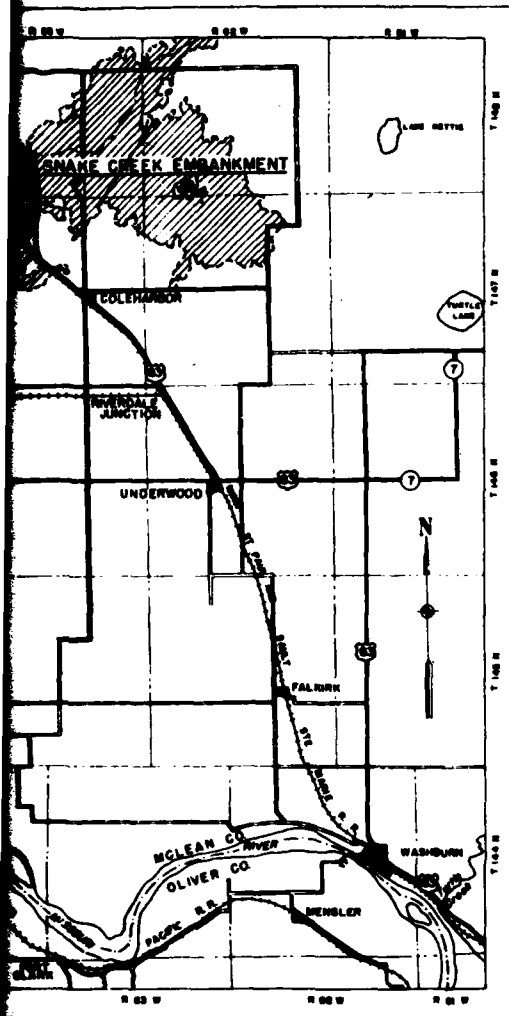


END  
DATE  
FILMED  
SEP 4  
DTIC





MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A



#### LOCATION MAP

SCALE IN MILES  
0 20 40 60 80 100

#### LEGEND

- HARD SURFACED HIGHWAY
- GRAVELED HIGHWAY
- IMPROVED ROAD
- UNIMPROVED ROAD
- FEDERAL HIGHWAY SYMBOL
- STATE HIGHWAY SYMBOL
- TOLL FERRY

#### DRAWINGS

28 MISCELLANEOUS METAL - REGULATING CONDUIT - GATE STRUCTURE	GR 21 - 10/1	GR 21 - 11/1
29 HIGHWAY AND RAILROAD - PLAN AND PROFILE - SHEET NO. 1	GR 21 - 10/2	GR 21 - 32/1
30 HIGHWAY AND RAILROAD - PLAN AND PROFILE - SHEET NO. 2	GR 21 - 10/3	GR 21 - 32/2
31 HIGHWAY AND RAILROAD - DETAILS	GR 21 - 10/4	GR 21 - 32/3
32 LOCATION OF BORINGS - MAIN EMBANKMENT	GR 21 - 10/5	GR 21 - 5/1
33 BORING PROFILES - CENTERLINE MAIN EMBANKMENT - LEGEND SHEET NO. 1	GR 21 - 10/5A	GR 21 - 5/2
34 BORING PROFILES - CENTERLINE MAIN EMBANKMENT - SHEET NO. 2	GR 21 - 10/6	GR 21 - 5/3
35 BORING PROFILES - CENTERLINE MAIN EMBANKMENT - SHEET NO. 3	GR 21 - 10/7	GR 21 - 5/4
36 BORING PROFILES - REGULATING CONDUIT AND FUTURE PUMPING CHANNEL	GR 21 - 10/8	GR 21 - 5/5
37 BORING PROFILES - BORROW AREA A - SHEET NO. 1	GR 21 - 10/9	GR 21 - 5/6
38 BORING PROFILES - BORROW AREA A - SHEET NO. 2	GR 21 - 10/10	GR 21 - 5/7
39 BORING PROFILES - BORROW AREA D - SHEET NO. 1	GR 21 - 10/11	GR 21 - 5/8
40 BORING PROFILES - BORROW AREA D - SHEET NO. 2	GR 21 - 10/12	GR 21 - 5/9
41 BORING PROFILES - BORROW AREA F - SHEET NO. 1	GR 21 - 10/13	GR 21 - 5/10
42 BORING PROFILES - BORROW AREA F - SHEET NO. 2	GR 21 - 10/14	GR 21 - 5/11
43 BORING PROFILES - BORROW AREA H & J		GR 21 - 5/12
44 RECORDS OF BORINGS - SHEET NO. 1		GR 21 - 5/13
45 RECORDS OF BORINGS - SHEET NO. 2		GR 21 - 5/14
46 RECORDS OF BORINGS - SHEET NO. 3		GR 21 - 5/15
47 RECORDS OF BORINGS - SHEET NO. 4		GR 21 - 5/16
48 RECORDS OF BORINGS - SHEET NO. 5		GR 21 - 5/17
49 RECORDS OF BORINGS - SHEET NO. 6		GR 21 - 5/18
50 RECORDS OF BORINGS - SHEET NO. 7		GR 21 - 5/19

1	3 2954	Revised Prior to Advertising	REV	DATE	BY	CHKD	APPD
<p>U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DISTRICT NO. 9</p> <p>MISSOURI RIVER GARRISON DAM AND RESERVOIR SNAKE CREEK EMBANKMENT PROJECT LOCATION AND INDEX</p> <p>FEBRUARY 1981</p> <p>GR 21 - 1/1</p>							

CONSTRUCTION FOUNDATION REPORT

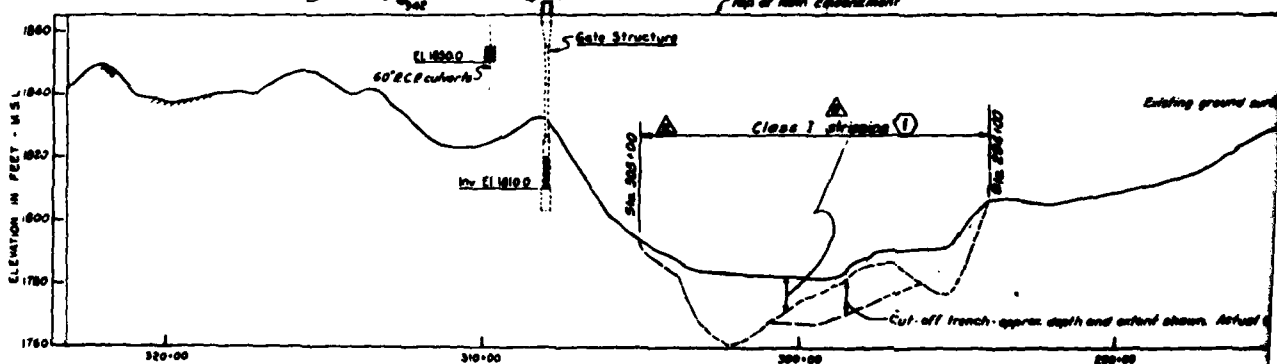
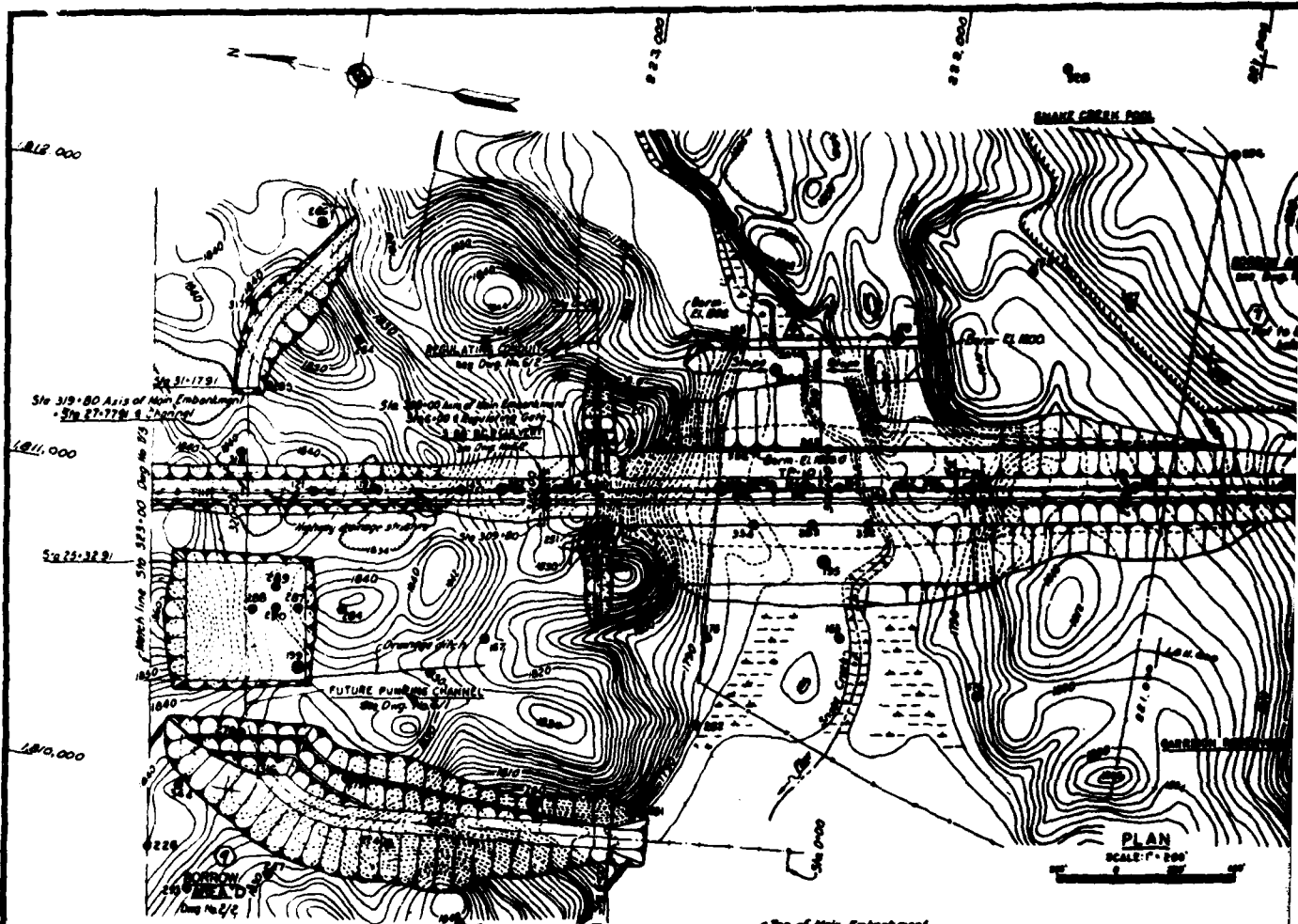
(1982)

PLATE 145





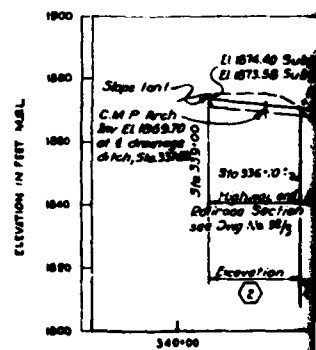
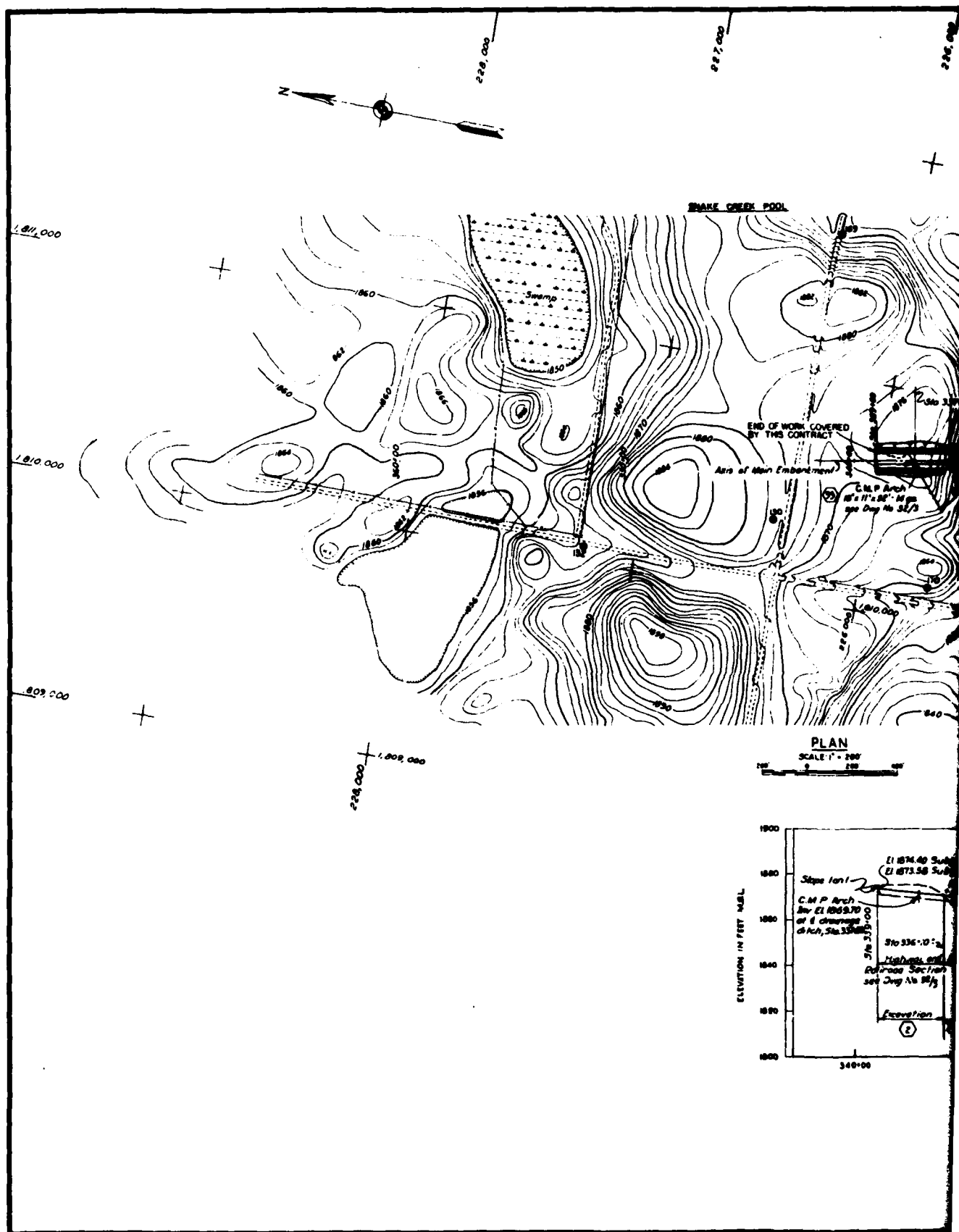


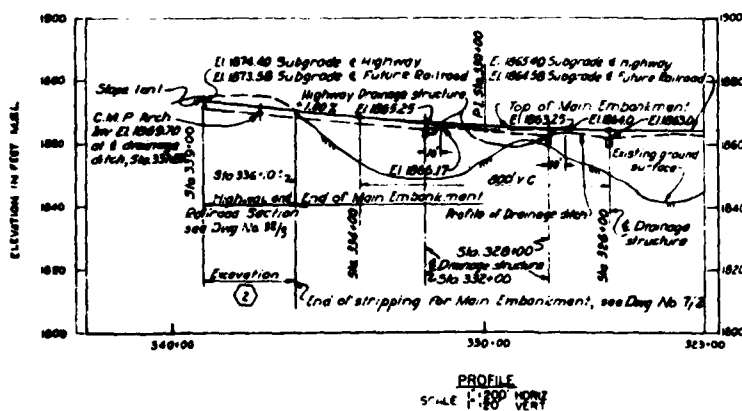
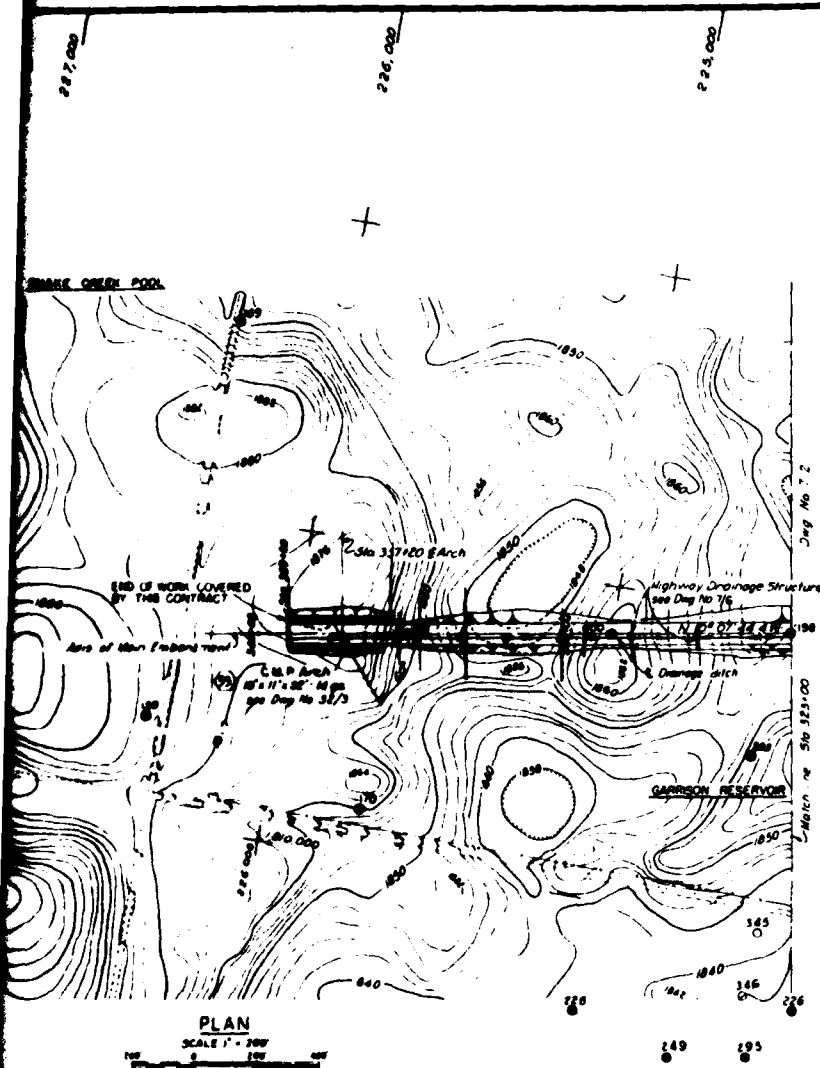


**STRIPPING NOTE:**  
 Stripping of main embankment area, except where shown as Class 1 or Class 2, shall be Class 3 stripping paid for under Item No. 18.

**PROFILE**  
 SCALE: VERT. 1" = 10'



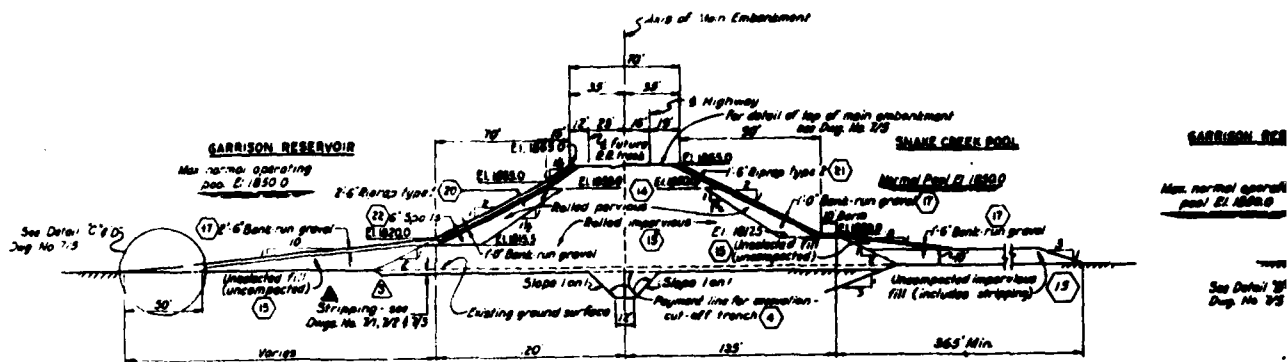




#### NOTES

Figures in parentheses indicate the number of days under which payment will be made.  
For continuation of Main Embankment, plan and profile, see Dings No. 7/1 and 7/2.  
For Main Embankment, Section, see Ding No. 7/4.  
For Main Embankment, Drains, see Ding No. 7/5.  
For Garrison Reservoir, plan sheet, see Dings No. 2/1 and 2/2.  
For Highway Drainage Structure, see Ding No. 7/6.  
Arrows shown on & Drainage ditch indicate direction that ditch shall be graded to drain.  
For Records of Borings and Profiles, see Dings No. 5/1 to 5/19 inclusive.

1. See B-1 Standard prior to advertising		2. See B-1 Standard prior to advertising	
DATE	DATE	DATE	DATE
U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER DISTRICT NO. 10			
MISSOURI RIVER GARRISON DAM AND RESERVOIR SNAKE CREEK EMBANKMENT MAIN EMBANKMENT PLAN AND PROFILE SHEET NO. 3			
FEBRUARY 1954		FEBRUARY 1954	
SCALE 1/2" = 20' HORIZ.		SCALE 1/2" = 20' VERT.	
GR21-773		GR21-773	



**TYPICAL SECTION NO. 1**

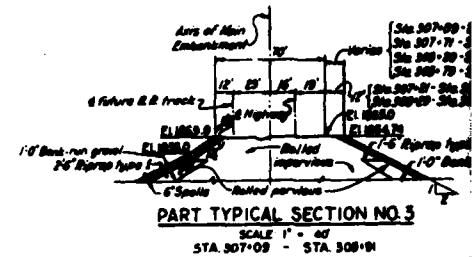
SCALE: 1" = 40'

STA 245+00 - STA 251+00

STA 250+00 - STA 256+00

STA 254+00 - STA 254+00

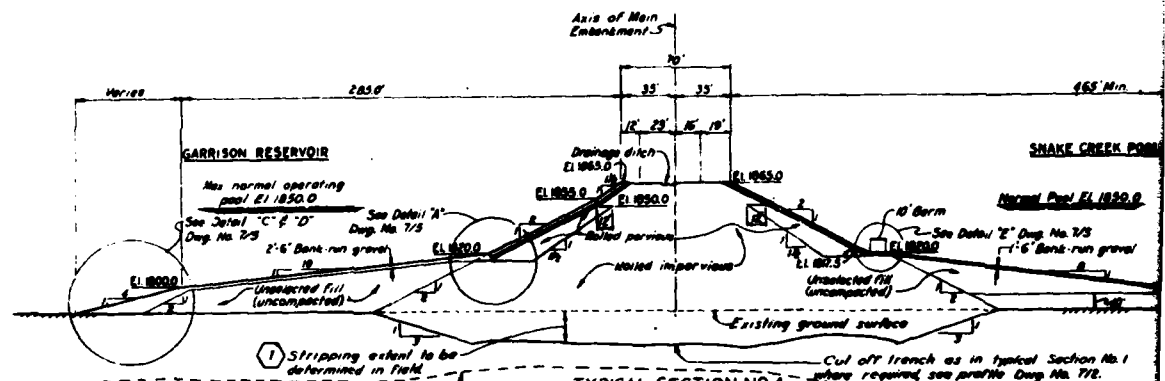
STA 255+00 - STA 257+00 (see Part Typical Section No. 3)



**PART TYPICAL SECTION NO. 3**

SCALE: 1" = 40'

STA 257+00 - STA 258+00

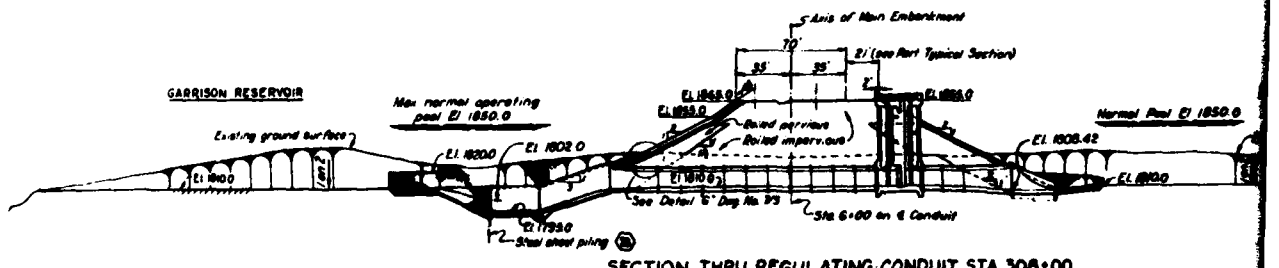


**TYPICAL SECTION NO. 4**

SCALE: 1" = 40'

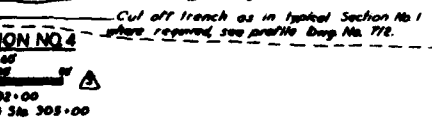
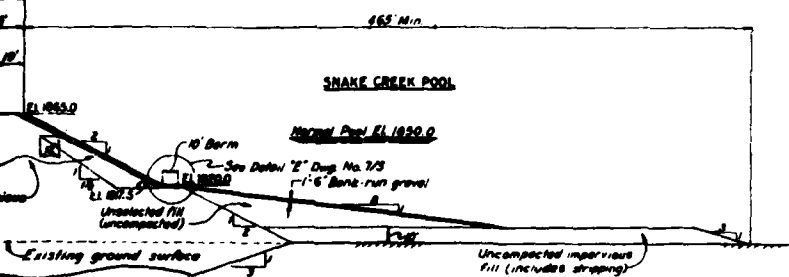
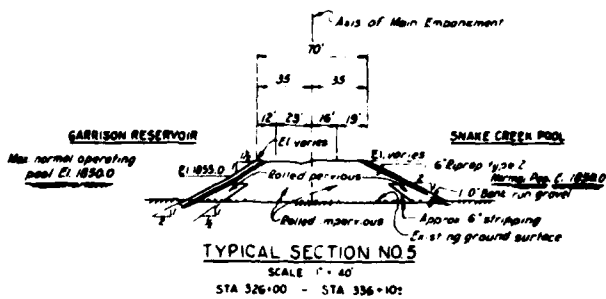
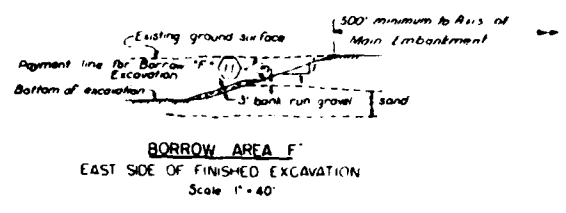
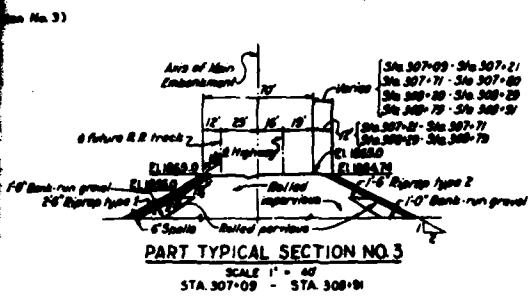
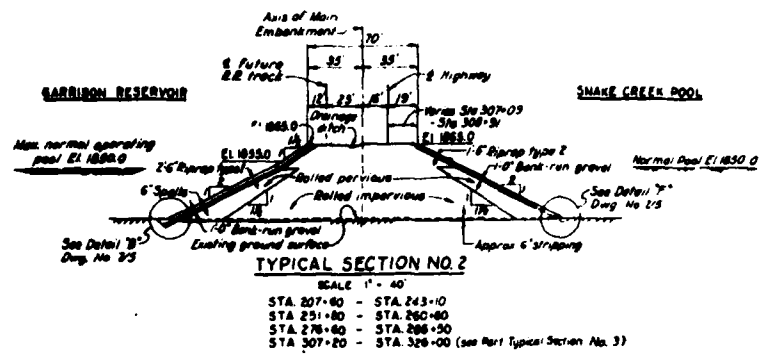
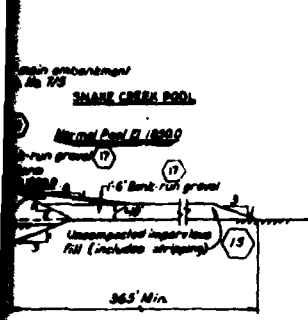
Section at Sta 302+00

Typical for Sta 294+00 to Sta 305+00

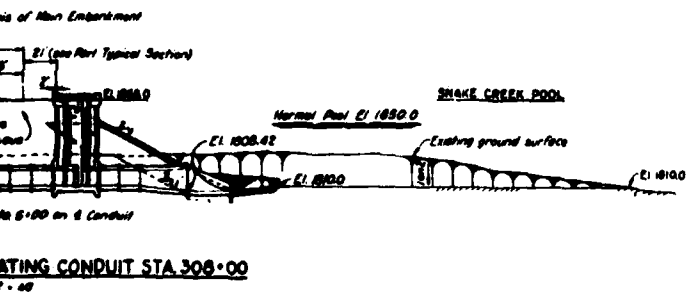


**SECTION THRU REGULATING CONDUIT STA 305+00**

SCALE: 1" = 40'



**NOTES**  
Figures in hexagons indicate item number under which payment will be made.  
For General Plans see Dwg. No. 2-1 & 2-2  
For Main Embankment, Plan and Profile, see Dwg. No. 7-1, 7-2 and 7-3  
For Highway Drainage Structures, see Dwg. No. 7-6  
For Excavation, Regulating Conduit, Plan, Profile and Sections, see Dwg. No. 6-2, 6-3 & 6-4  
For Regulating Conduit, Concrete, see Dwg. No. 10-1 thru 10-14



3	4-27-51	Section No. 1 & Addendum No. 2	PLD	WLD	WLD
2	4-28-51	Addendum No. 1	PLD	WLD	WLD
1	5-28-51	Revised prior to advertising	PLD	WLD	WLD

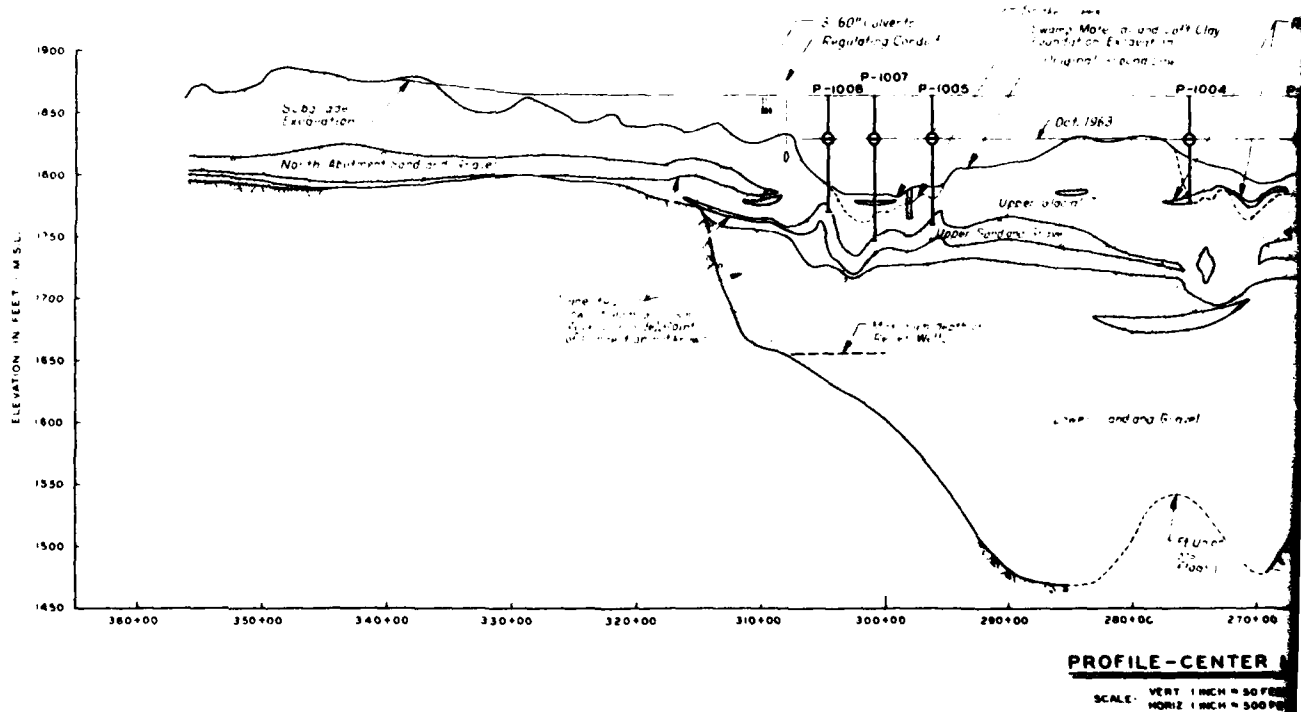
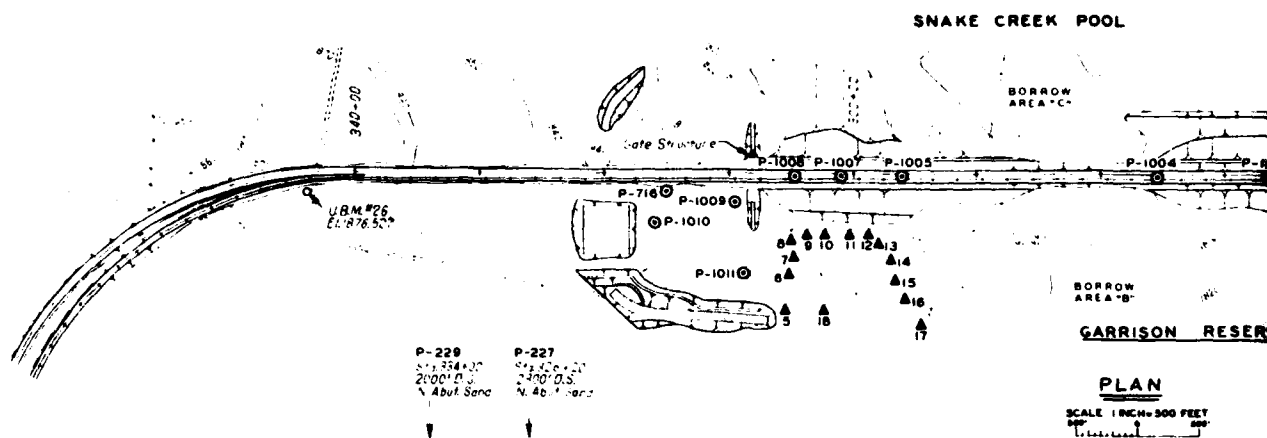
DESIGNED BY: [Signature]  
CHECKED BY: [Signature]  
DATE: [Signature]

U. S. ARMY  
CORPS OF ENGINEERS  
OFFICE OF THE DISTRICT ENGINEER  
MISSOURI RIVER  
**GARRISON DAM AND RESERVOIR**  
SNAKE CREEK EMBANKMENT  
**MAIN EMBANKMENT**

SECTIONS  
FEBRUARY 1951  
CR21-774

2

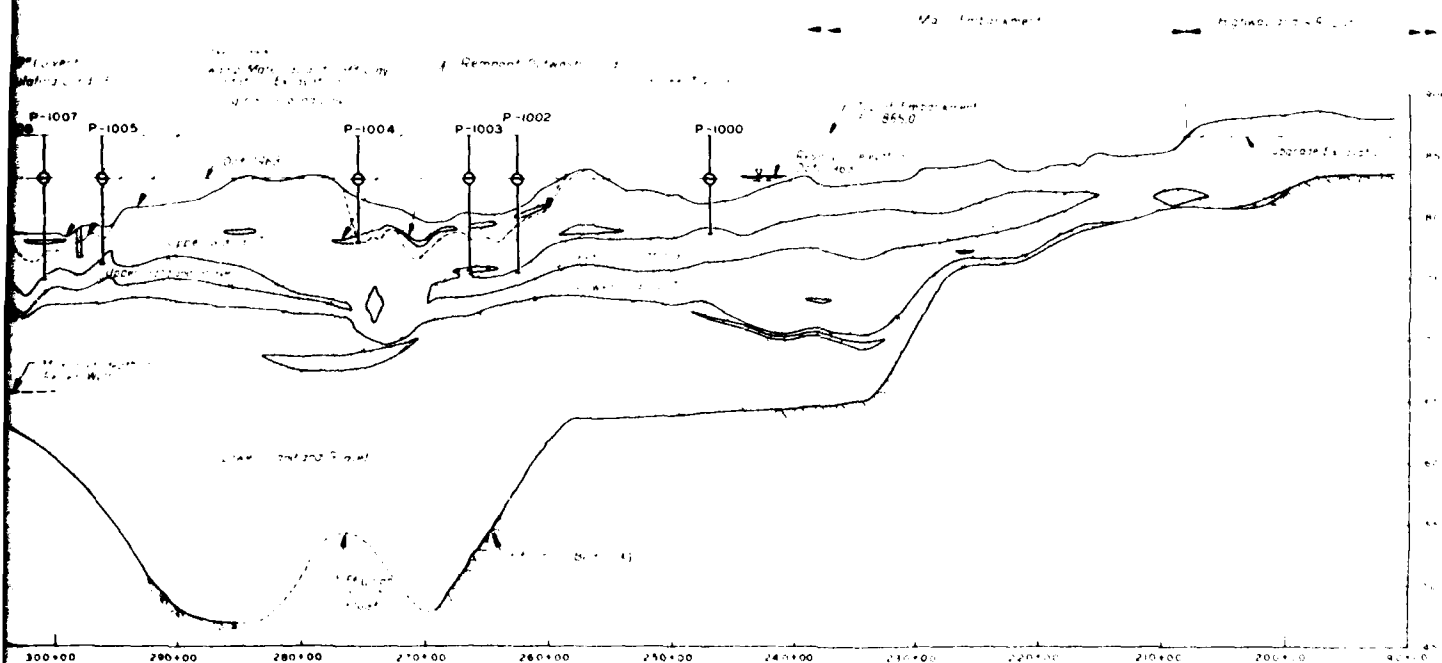
**CORPS OF ENGINEERS**

[illegible]



## PLAN

SCALE 1 INCH = 500 FEET



PROFILE-CENTER LINE

SCALE    VERT 1 INCH = 50 FEET  
          HORIZ 1 INCH = 500 FEET

**LEGEND:**

- ② ZONE OF GYPSUM FILLED CRACKS
- ③ GLACIAL TILL
- ④ ALLUVIUM (SAND & GRAVEL WITH THIN SILT & CLAY LENSES)
- ⑤ FT UNION (BEDROCK)
- ⑥ PIEZOMETERS
- ⑦ RELIEF WELLS

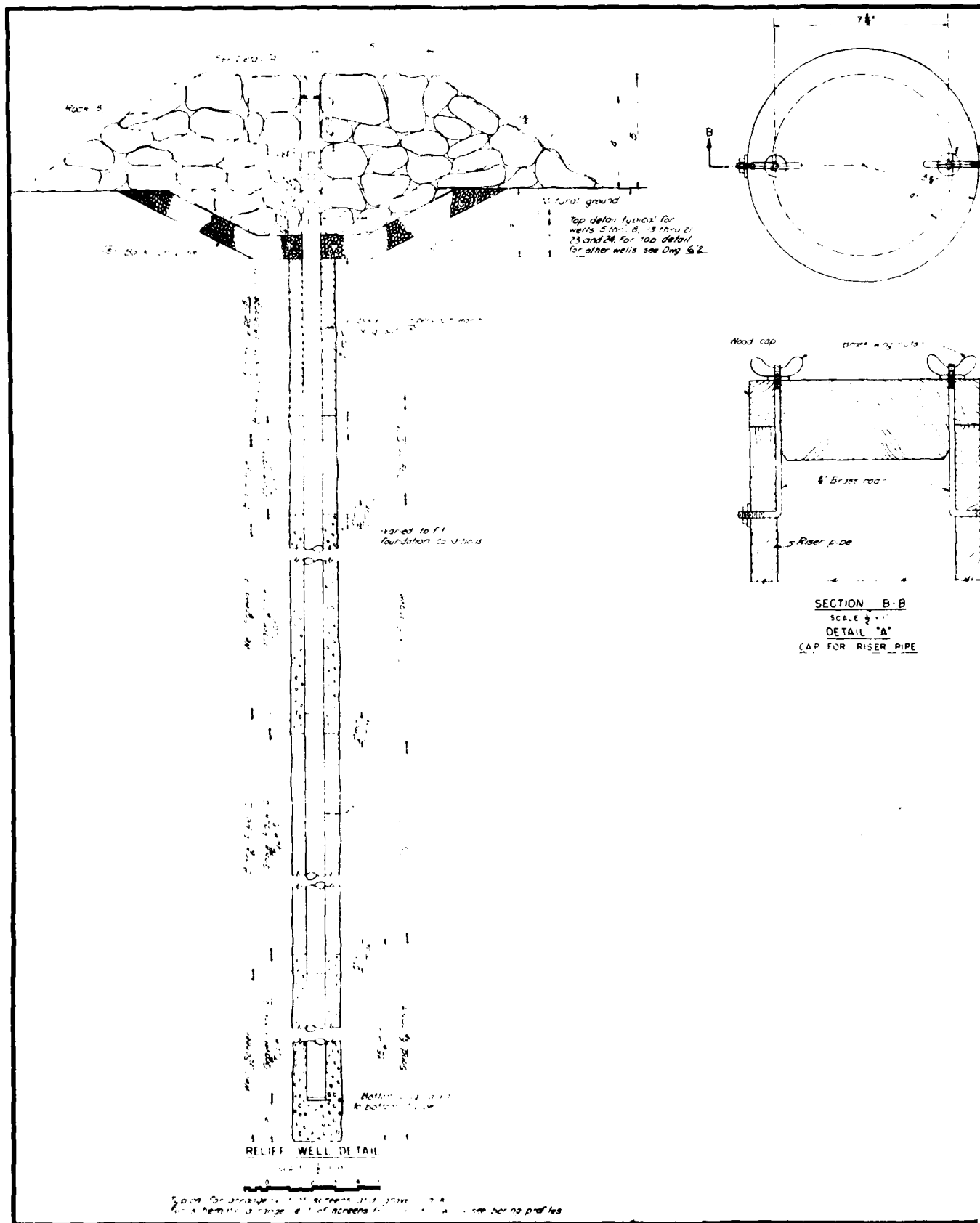
THIS DOCUMENT HAS BEEN REPRODUCED AS IS, WITHOUT  
 ANY EDITING OR CORRECTIONS FOR ORIGIN, SOURCE

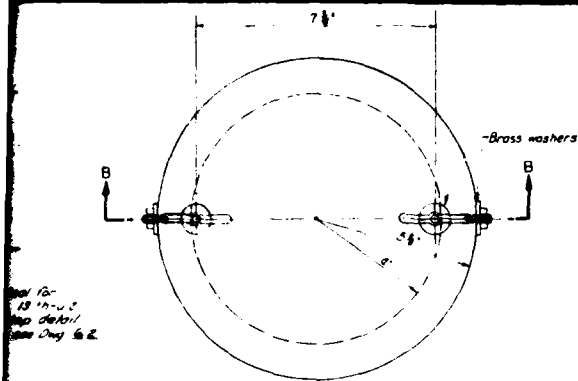


THIS PLAN ACCOMPANIES CONTRACT NO.  
DA-28-086-02 MODIFICATION NO.

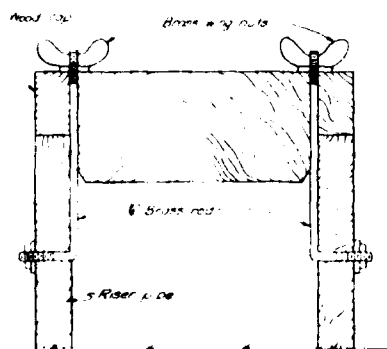
DATE		DESCRIPTION		PAGE		APPV	
SECTION							
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA							
RECEIVED BY		BY		MISSOURI RIVER			
DATE OF		DATE OF		GARRISON DAM AND RESERVOIR			
THRU		THRU		UNDERSEEPAGE STUDIES			
RECEIVED BY		BY		SNAKE CREEK EMBANKMENT			
DATE OF		DATE OF		PLAN AND PROFILE			
THRU		THRU					
APPROVED BY		APPROVED BY		DATE		EXT.	
<i>W. J. [Signature]</i> W. J. [Signature]		<i>Charles T. [Signature]</i> Charles T. [Signature]		1941		100	
DIST. TO AM APPROVED		DIST. TO [unclear] APPROVED		DATE 1941		EXT. NO. [unclear]	
<i>W. J. [Signature]</i> W. J. [Signature]		<i>Charles T. [Signature]</i> Charles T. [Signature]		1941		100	



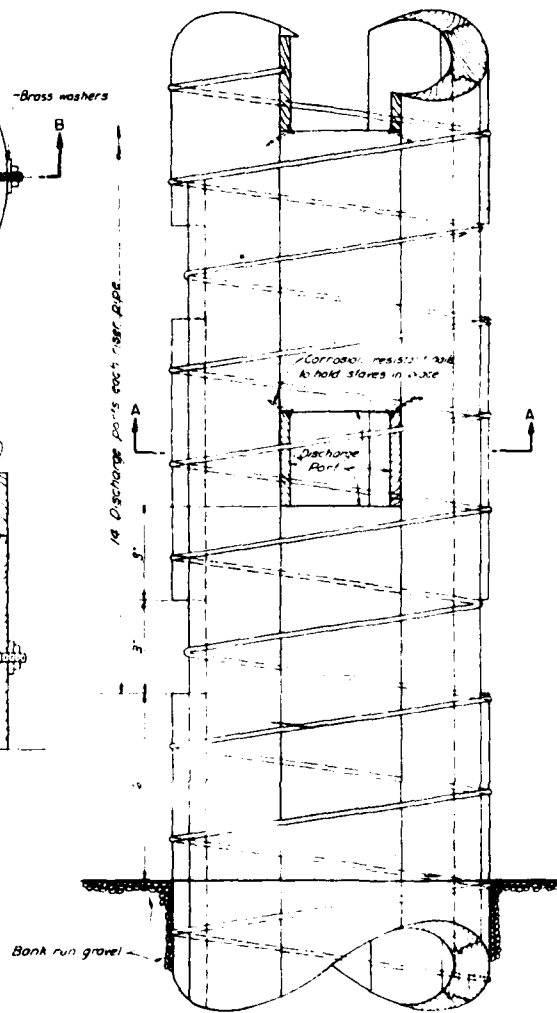




Not for  
13 inch  
top detail  
see only to B



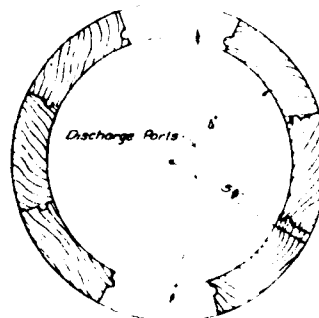
SECTION B-B  
SCALE 1/2" = 1'  
DETAIL "A"  
CAP FOR RISER PIPE



ELEVATION  
SCALE 1/2" = 1'



WELL



SECTION A-A  
SCALE 1/2" = 1'  
RISER PIPE

It is noted we  
will require 6 or  
more staggered

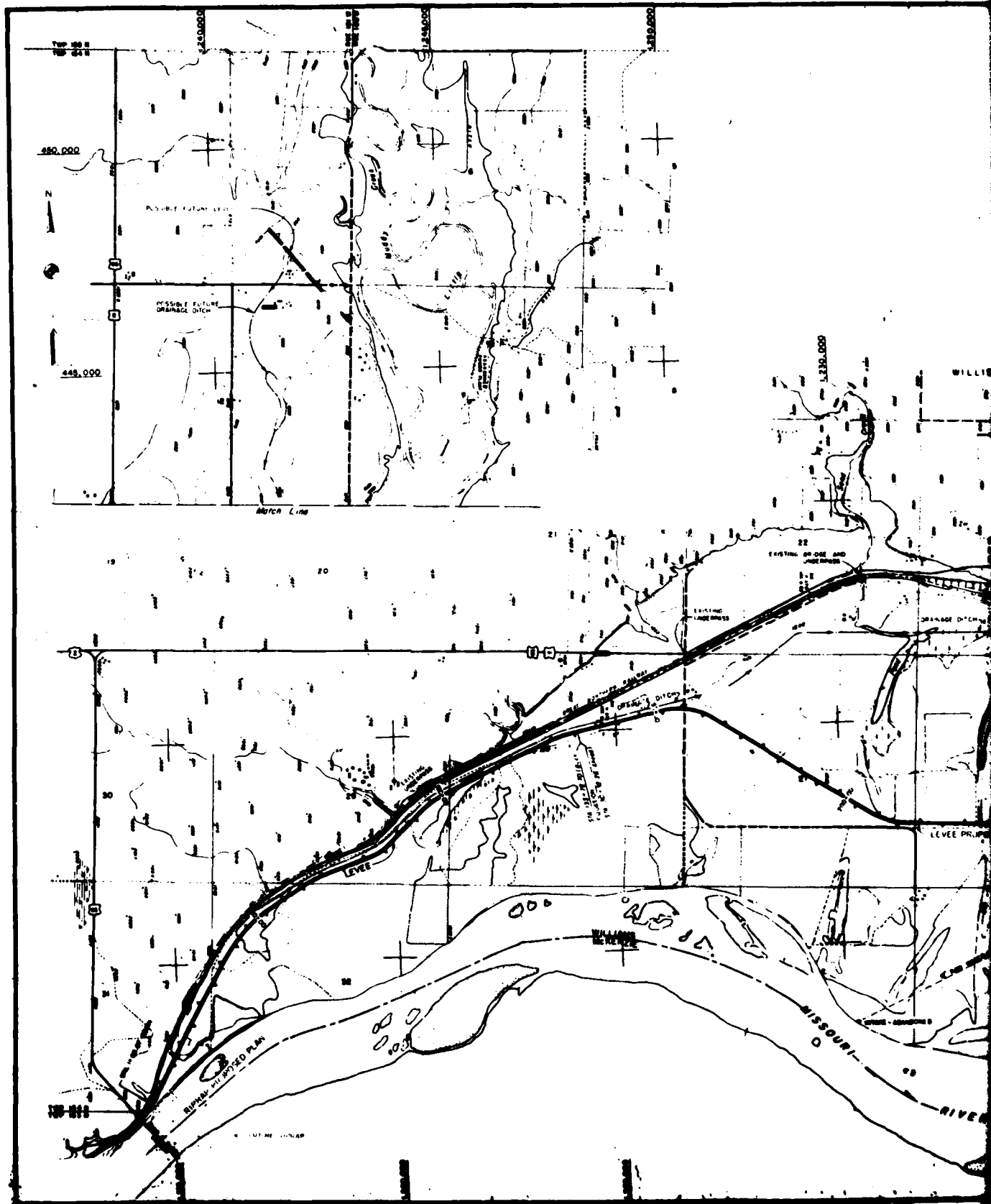
REV	DATE	REVISION
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

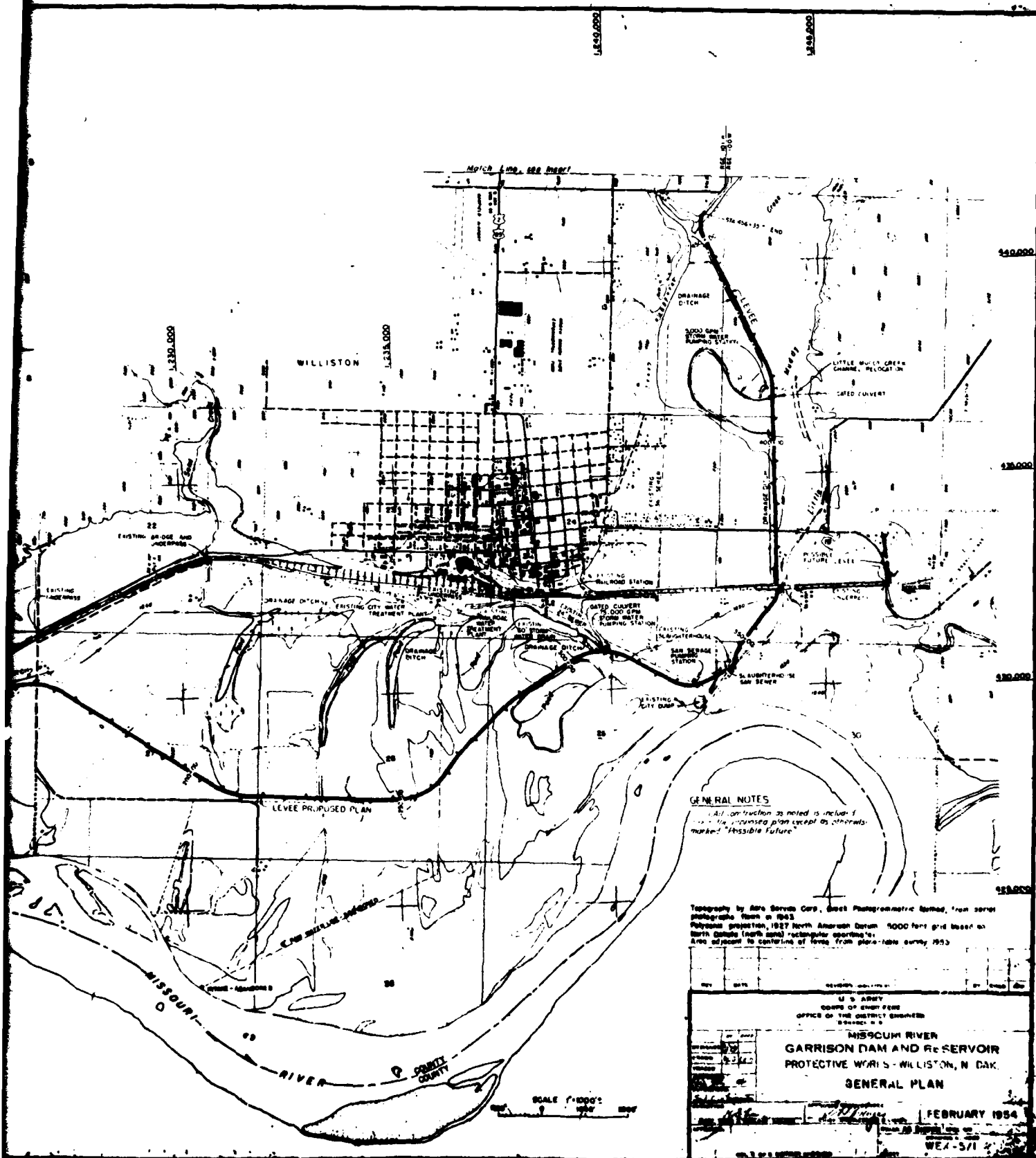
CONSTRUCTION FOUNDATION REPORT

GARRISO SNAKE

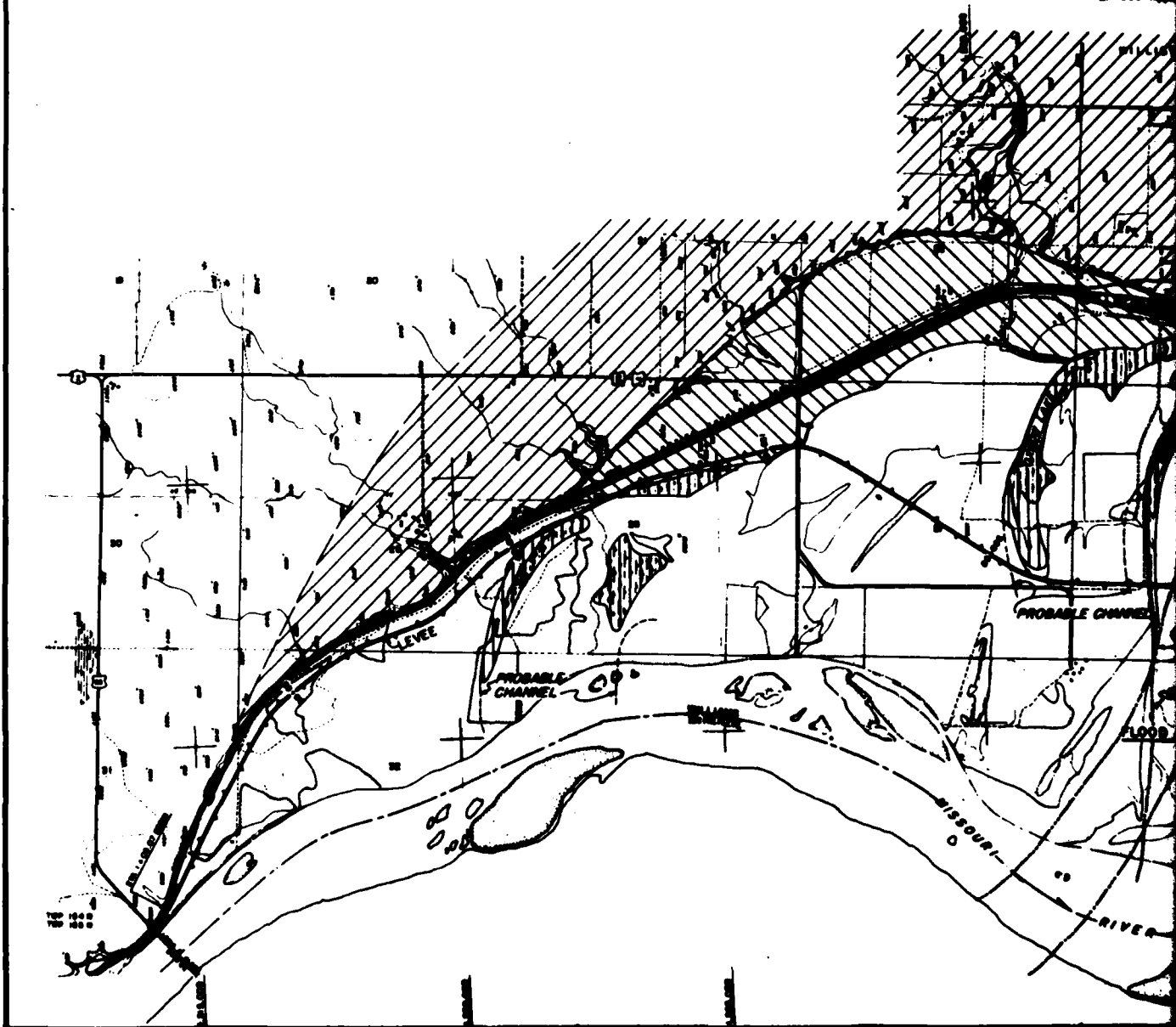
REV. 11/11/82

11/11/82

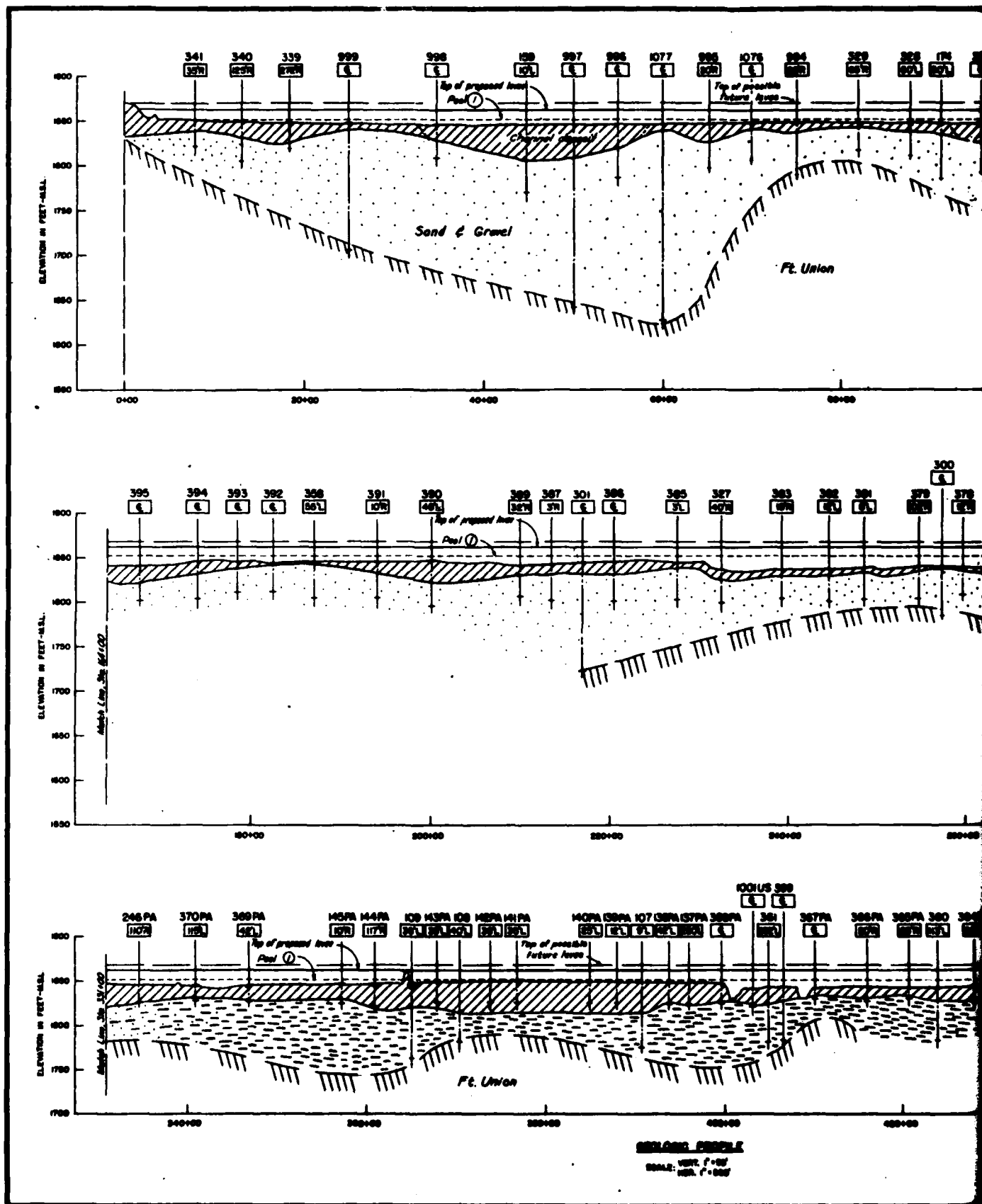


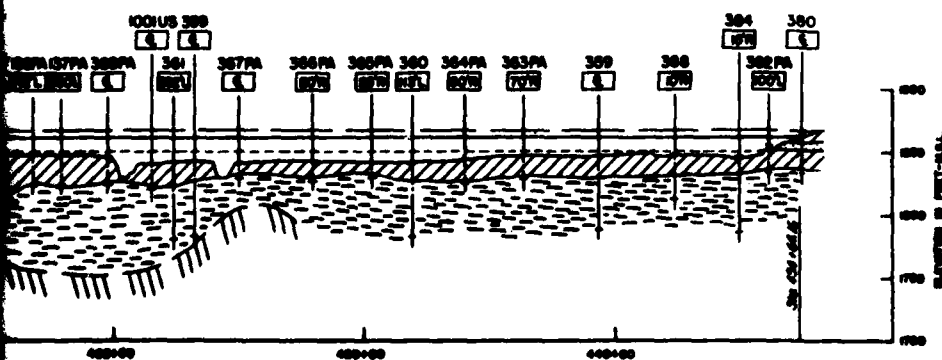
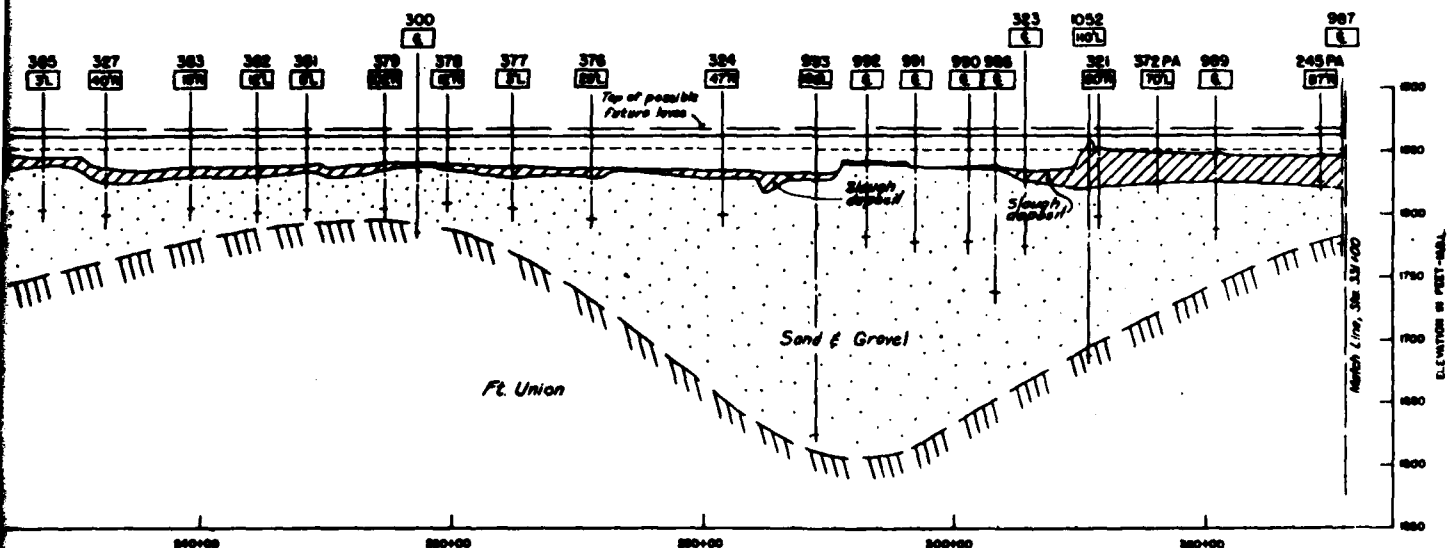
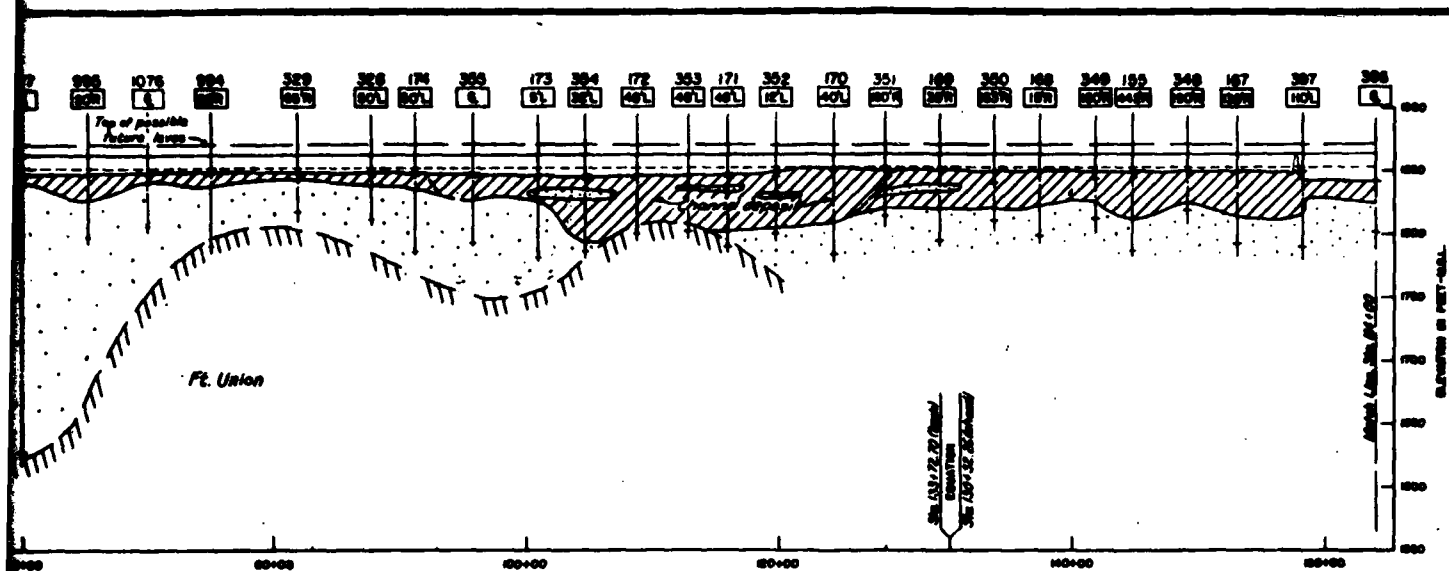


WILLISTON T<sup>h</sup>  
D. 1900/ App







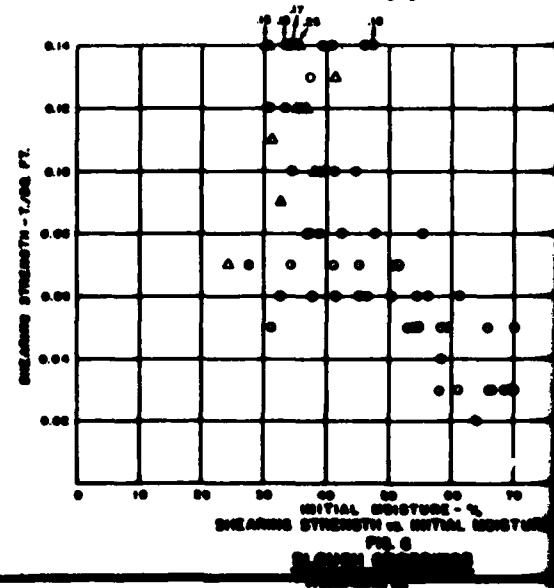
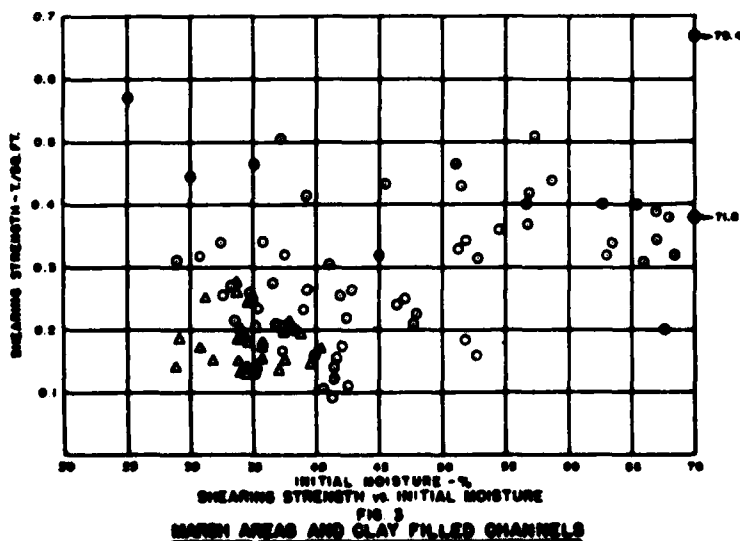
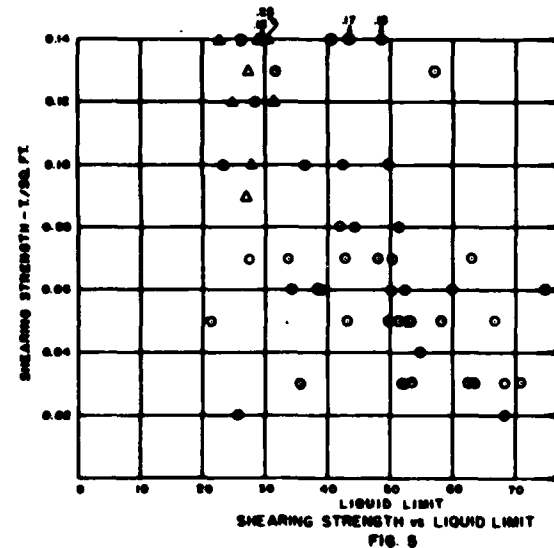
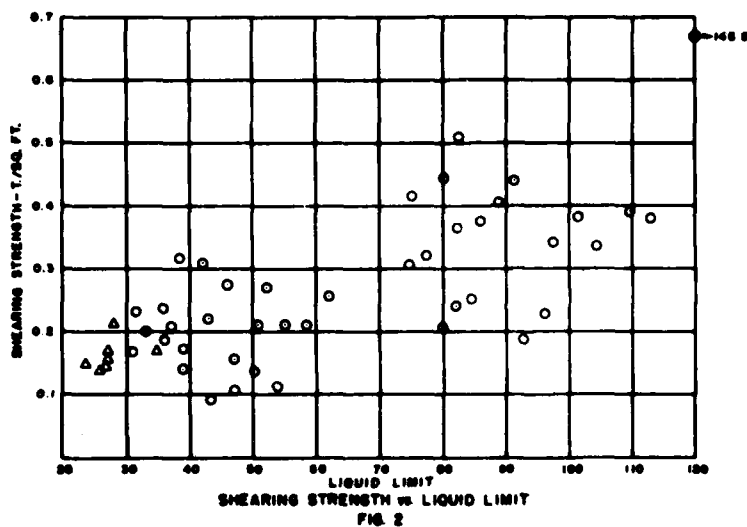
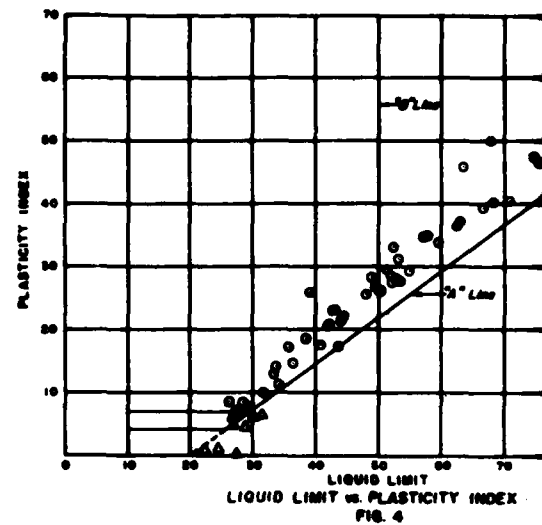
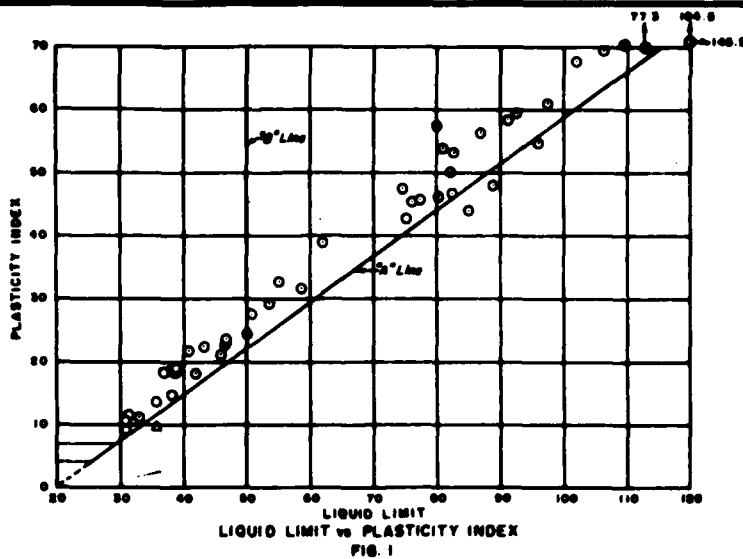


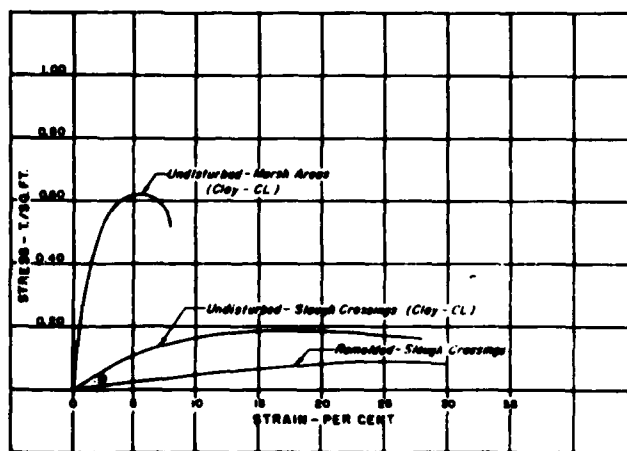
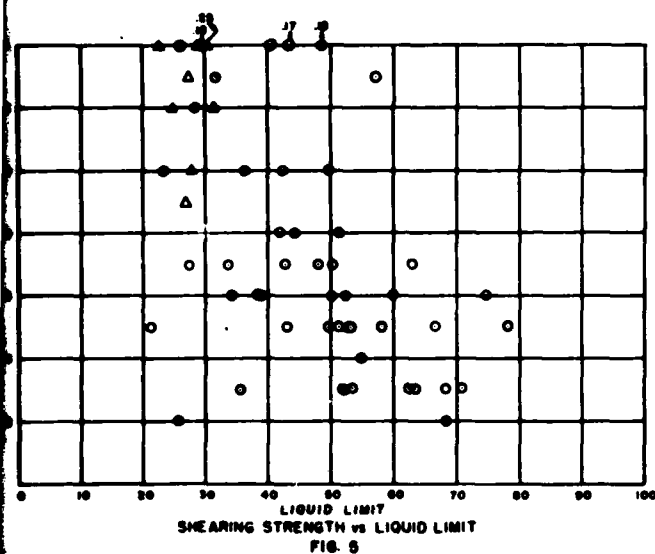
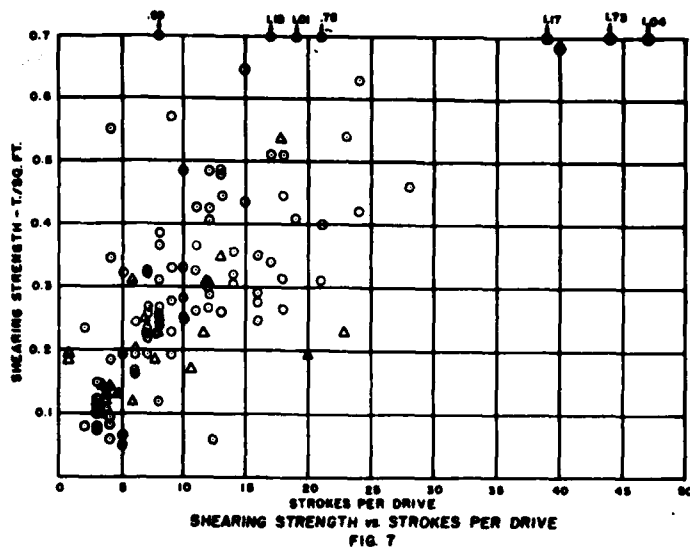
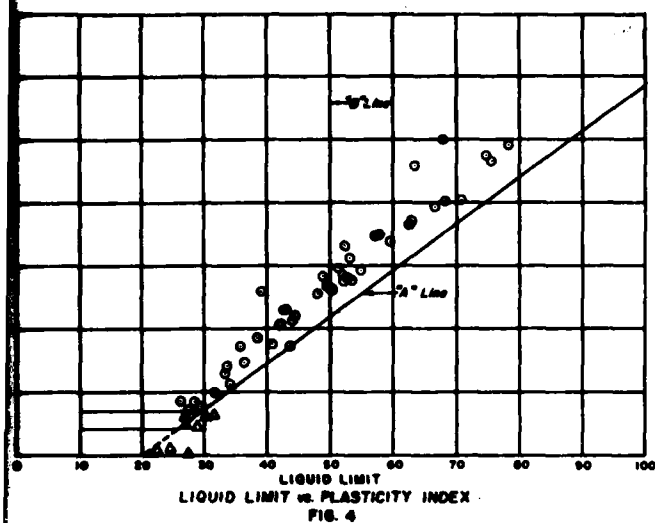
- Natural Blanket (Clays & Silts)
- Sands & Gravels
- Clays, Silts, Sands & Gravels
- Ft. Union

PLATE PROFILE  
SCALE: VERT. 1"=20'  
HORIZ. 1"=100'

U. S. ARMY CORPS OF ENGINEERS OFFICE OF THE DISTRICT ENGINEER MINNAPOLIS, MINN.	
MISSOURI RIVER GARRISON DAM AND RESERVOIR PROTECTIVE WORKS-WILLISTON, N. DAK. GENERALIZED GEOLOGIC PROFILE CENTER LINE OF LEVEE	
DATE: FEBRUARY 1964	BY: [Signature]
DRAWN BY: [Signature]	
CHECKED BY: [Signature]	
EX-6/3	







TYPICAL STRESS-STRAIN CURVE FOR UNCONFINED COMPRESSION TESTS  
FIG. 8

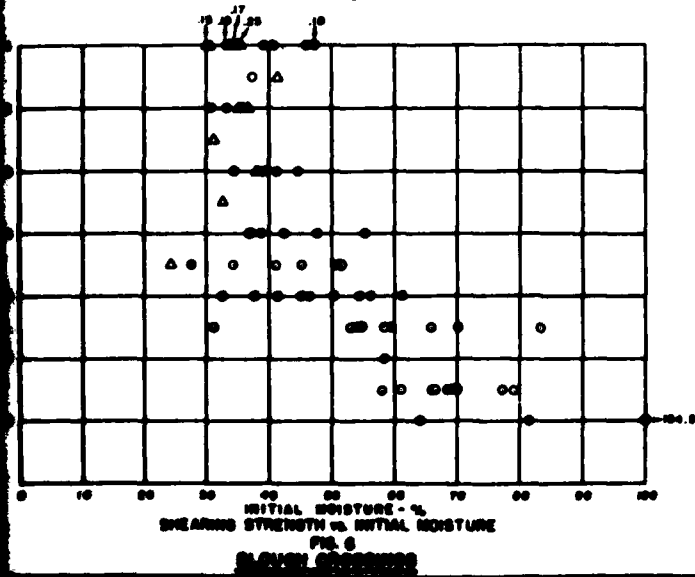
## NOTES

Strokes per drive obtained from churn drilling.  $\frac{1}{2}$  11 drive using a 6" sampling tube and a 2' drop of drilling fluid weighing approximately 1500 pounds

○ Denotes clay samples

$\Delta$  Denotes silt sample

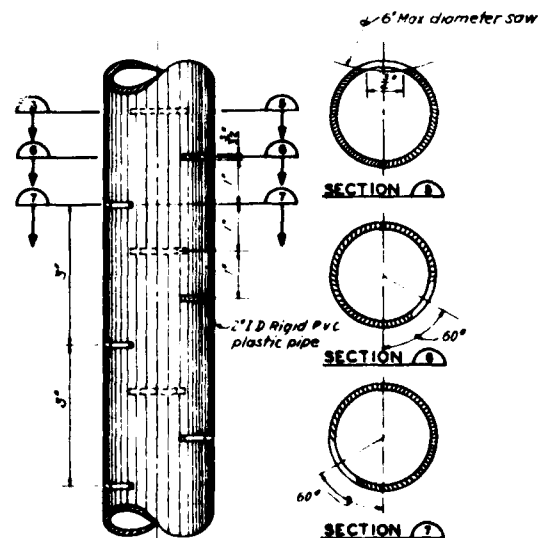
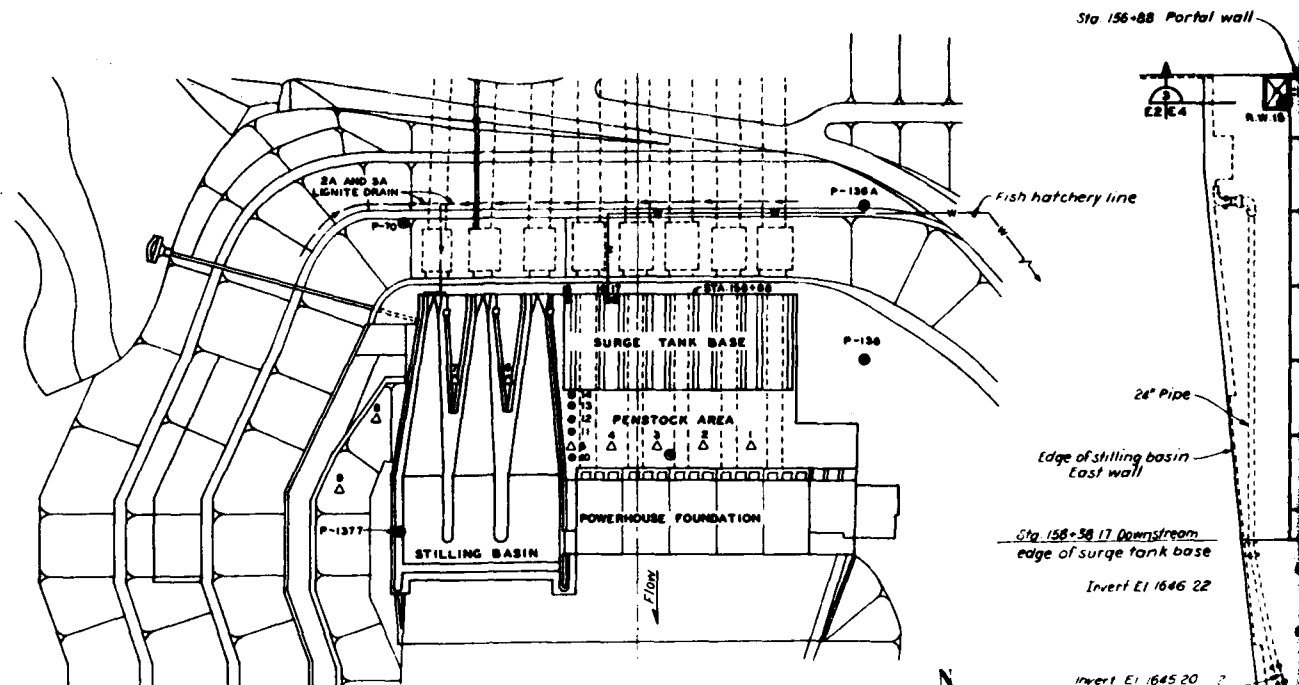
Shearing strength computed as one half the unconfined compressive strength of undisturbed samples. Data taken from C.U.'s, Aug. Nos. 5/24 & 5/25, not including test results marked as questionable.



**U S ARMY**  
**ENGINEER REGIMENT**  
**OFFICE OF THE CHIEF ENGINEER**  
**MISSOURI RIVER**  
**GARRISON DAM AND RESERVOIR**  
**PROTECTIVE WORKS - WILLISTON, N DAK.**  
**SOILS TEST DATA**  
**FOUNDATION SUMMARY**

**FEBRUARY, 1964**

**WEN-3780**

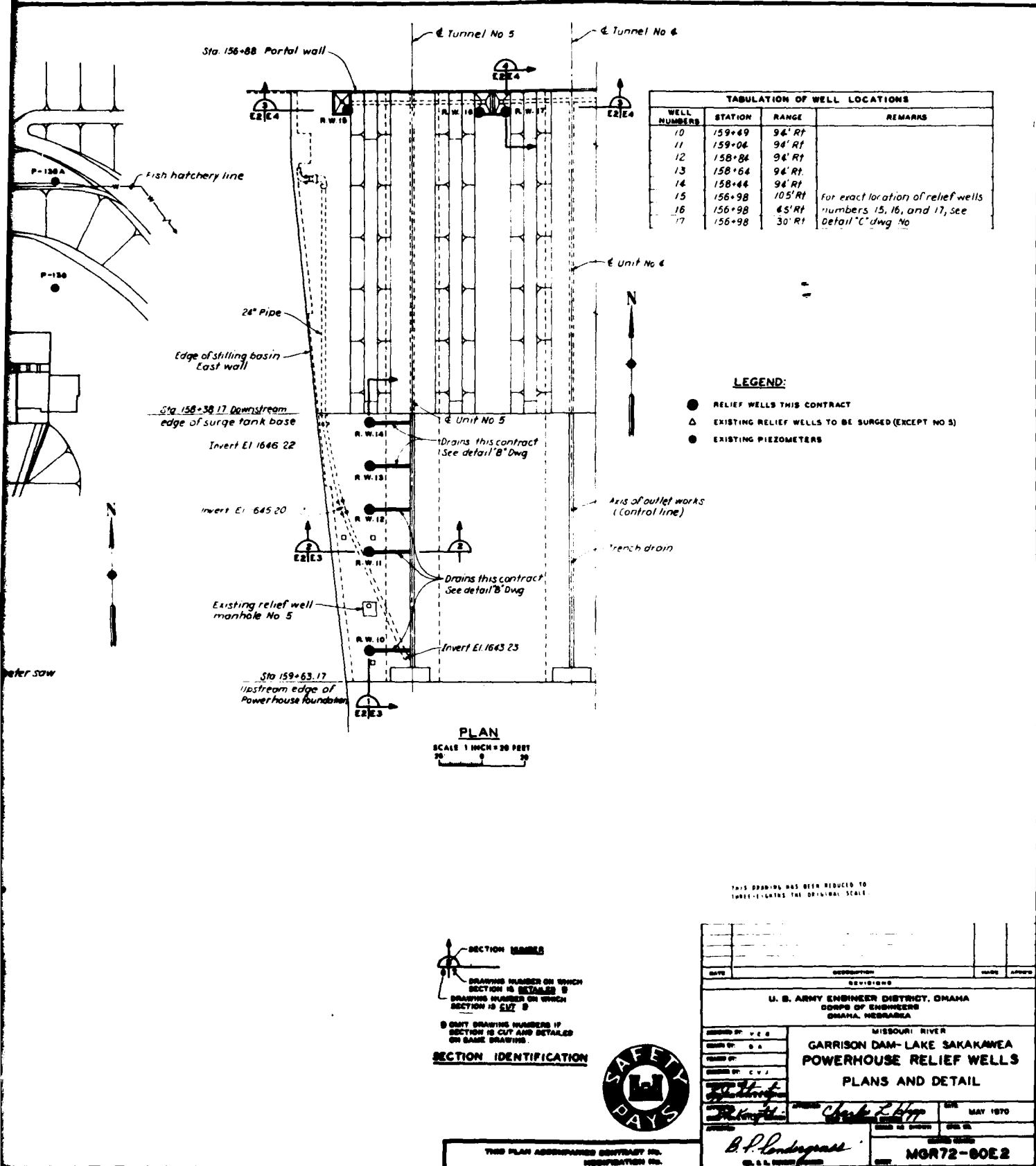


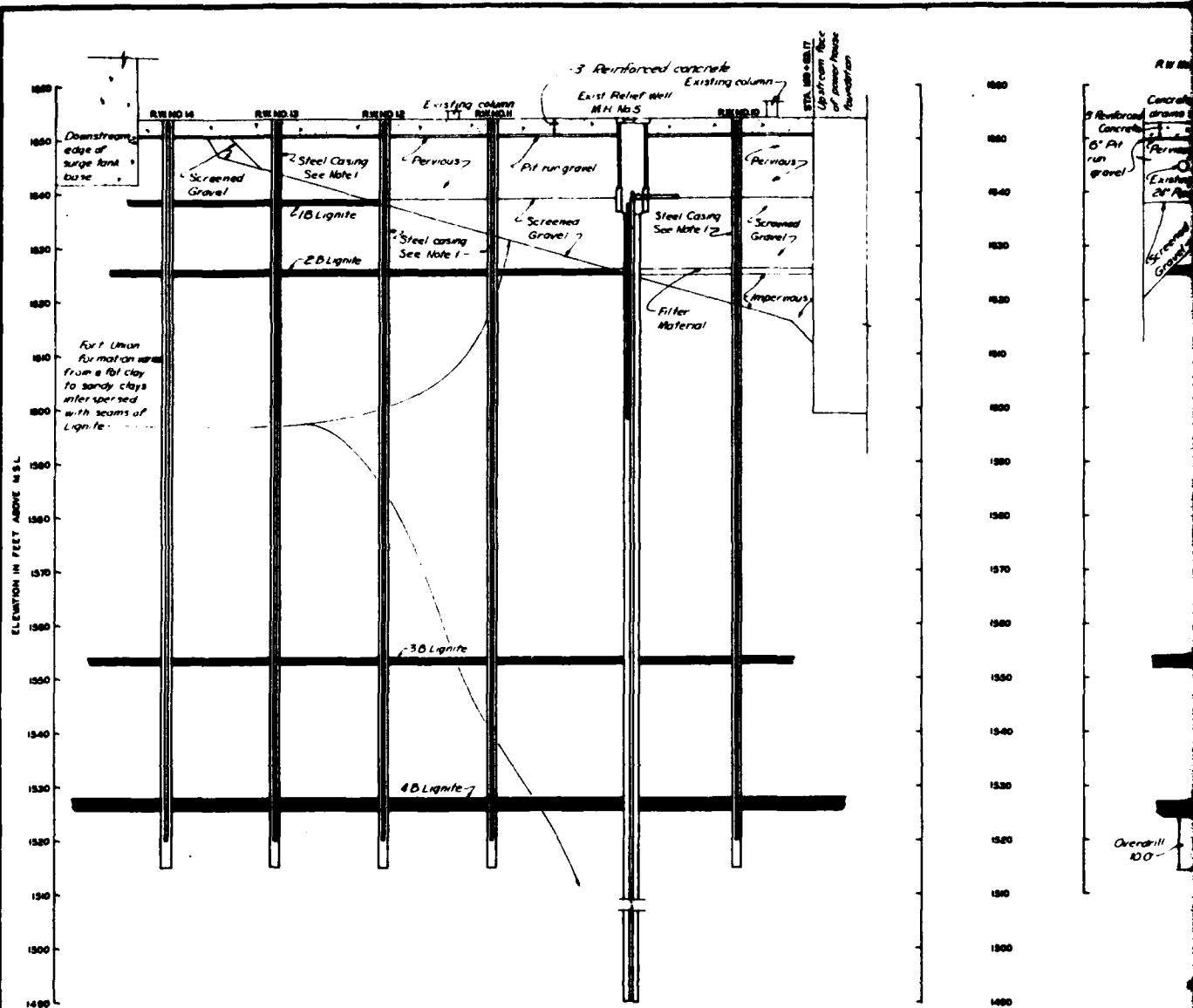
DETAIL

SLOT ARRANGEMENT FOR PLASTIC SCREEN

DEAD END POST

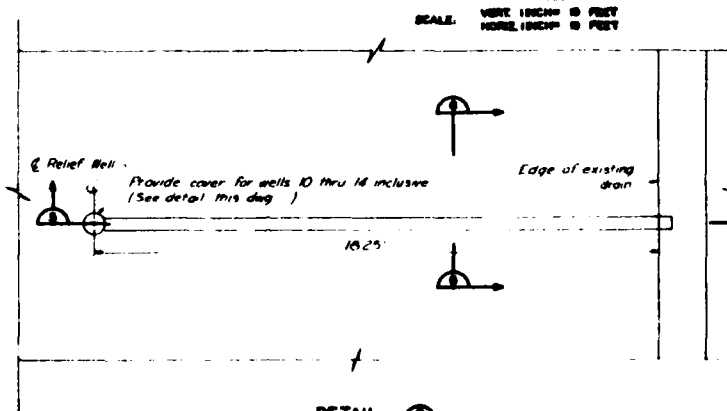
2" x 2"





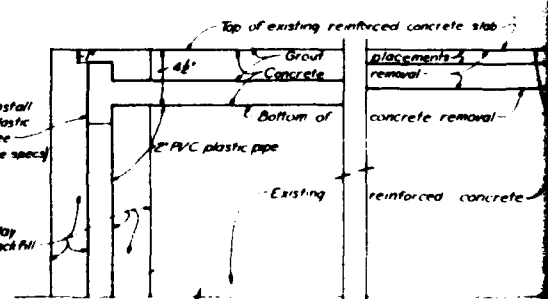
### SECTION 1

SCALE: VERT. 1/8" = 1' HORIZ. 1/8" = 1' 0"



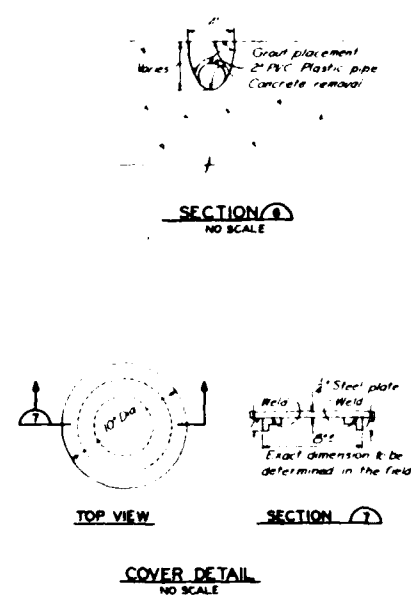
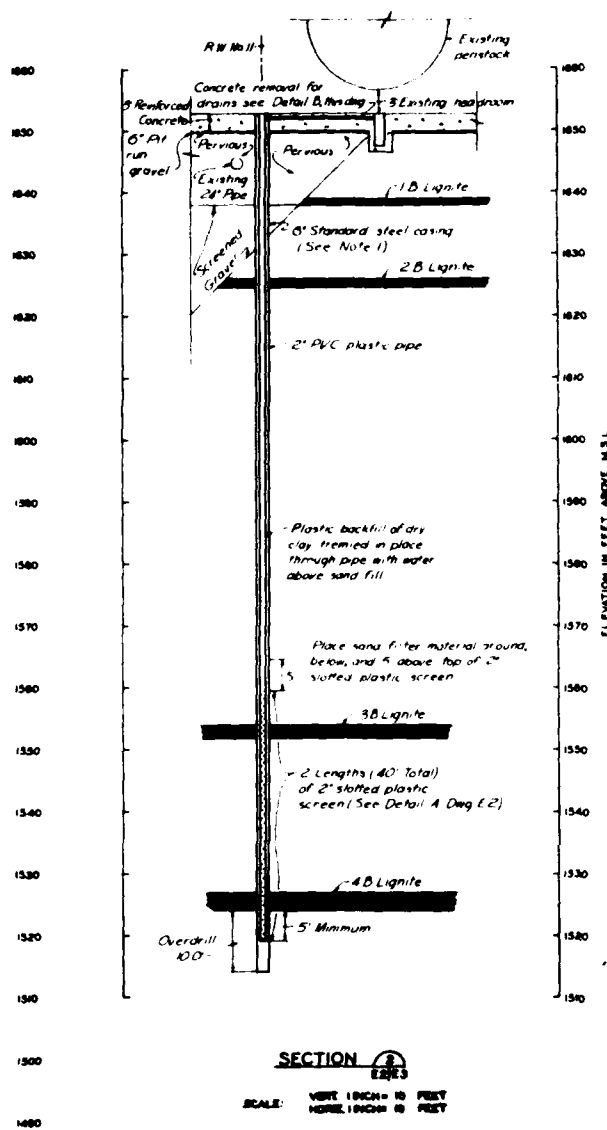
### DETAIL 1

NO SCALE



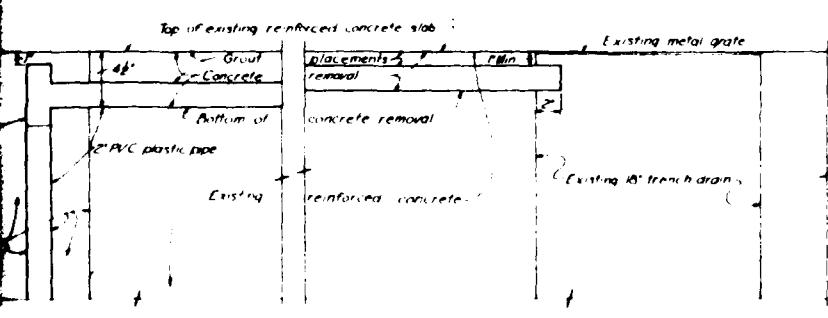
### SECTION 2

NO SCALE



**NOTE**  
1. Use 6" standard steel casing through pervious material and 5" into fast Union formation on wells numbered 10, 11, 12, and 13.

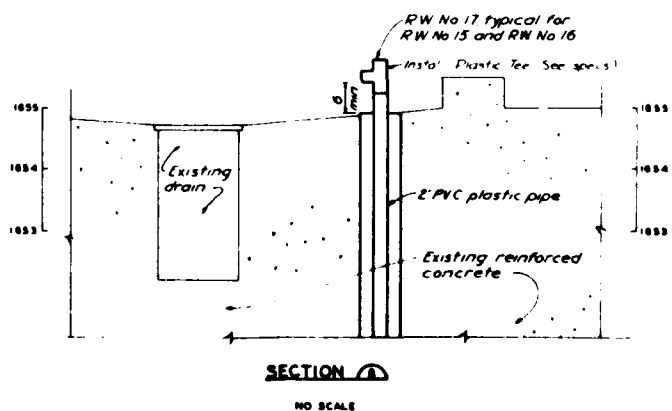
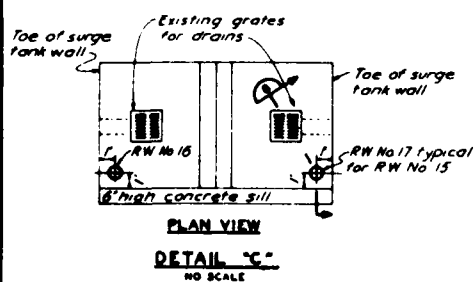
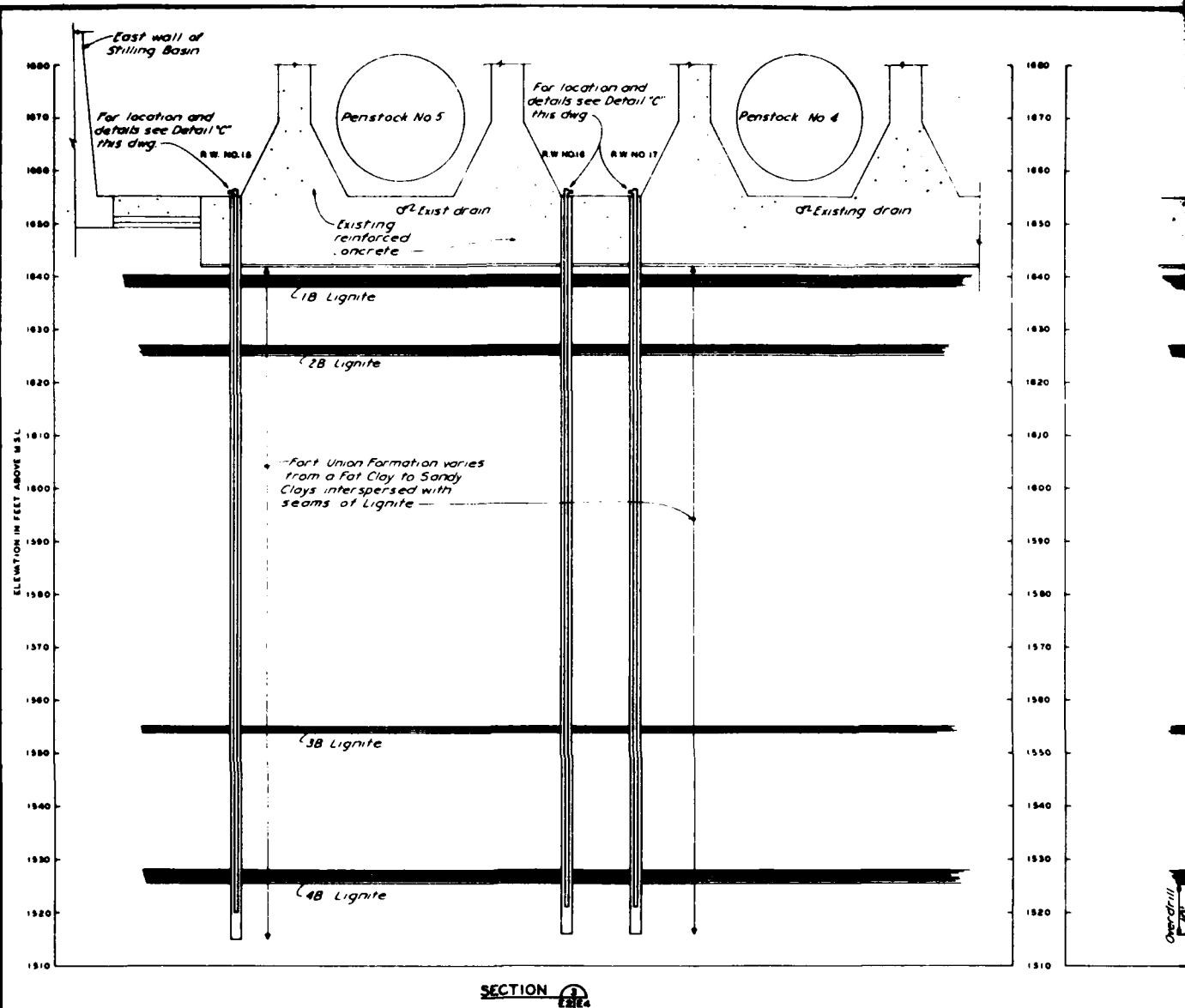
THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

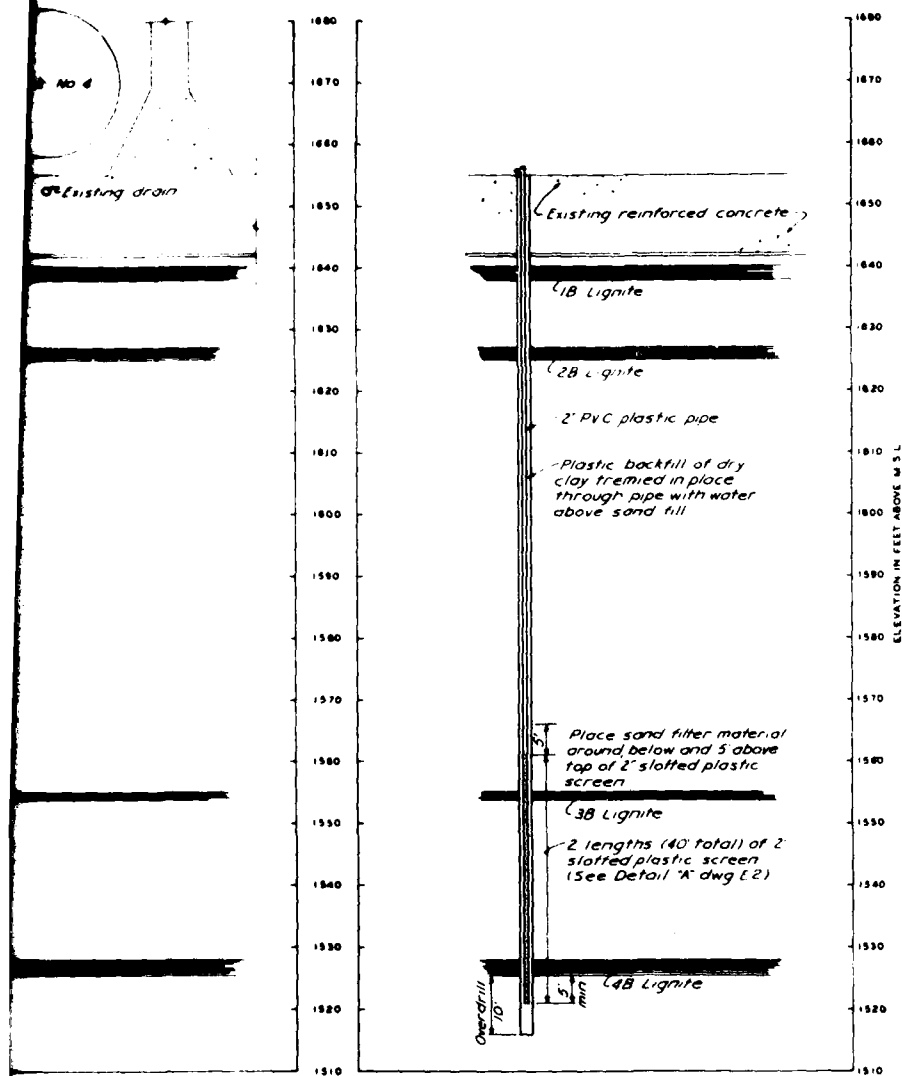


THIS PLAN ACCOMPANIES CONTRACT NO. IDENTIFICATION NO.

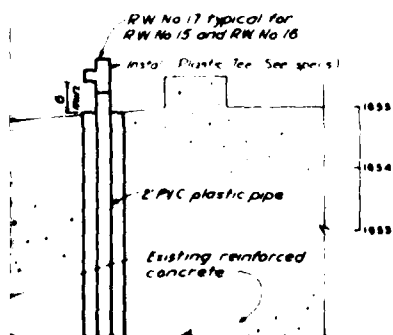
DATE	REVISION	NAME	APPROV
U. S. ARMY ENGINEER DISTRICT, OMAHA CORPS OF ENGINEERS OMAHA, NEBRASKA			
MISSOURI RIVER GARRISON DAM-LAKE SAKAKAWEA POWERHOUSE RELIEF WELLS SECTIONS AND DETAILS SHEET 1			
DESIGNED BY: V.E.G.	DRAWN BY: M.B.H.		CHECKED BY: C.V.J.
APPROVED BY: <i>Charles L. Bopp</i>		DATE: MAY 1970	
BY: <i>B.P. Lindgren</i>		DATE: MAY 1970	
MGR72-80E3			

2





SECTION 4  
RELIEF WELL NO. 17  
TYPICAL FOR RELIEF WELLS NO. 15 AND NO. 16



SECTION 1

NO SCALE

THIS DRAWING HAS BEEN REVISIONED  
10011-1-10-78-101 28 1-82



U. S. ARMY ENGINEER CORPS OF ENGINEERS GARRISON POWERHOUSE SECTION	
DESIGNED BY: <i>[Signature]</i>	CHECKED BY: <i>[Signature]</i>
DRAWN BY: <i>[Signature]</i>	APPROVED BY: <i>[Signature]</i>
B. P. Rodriguez U. S. ARMY ENGINEER	

CONSTRUCTION FOUNDATION REPORT

(1982)

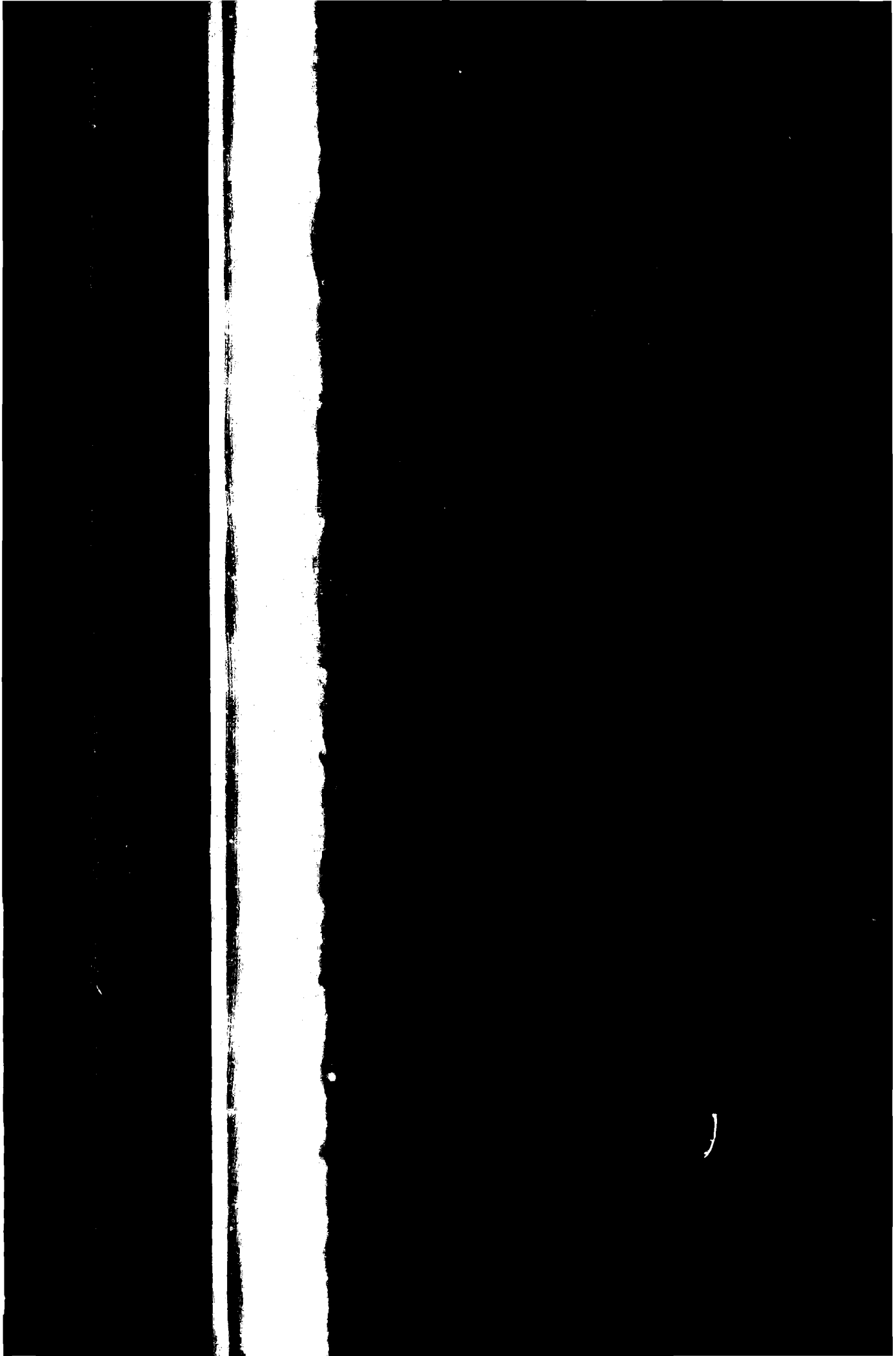


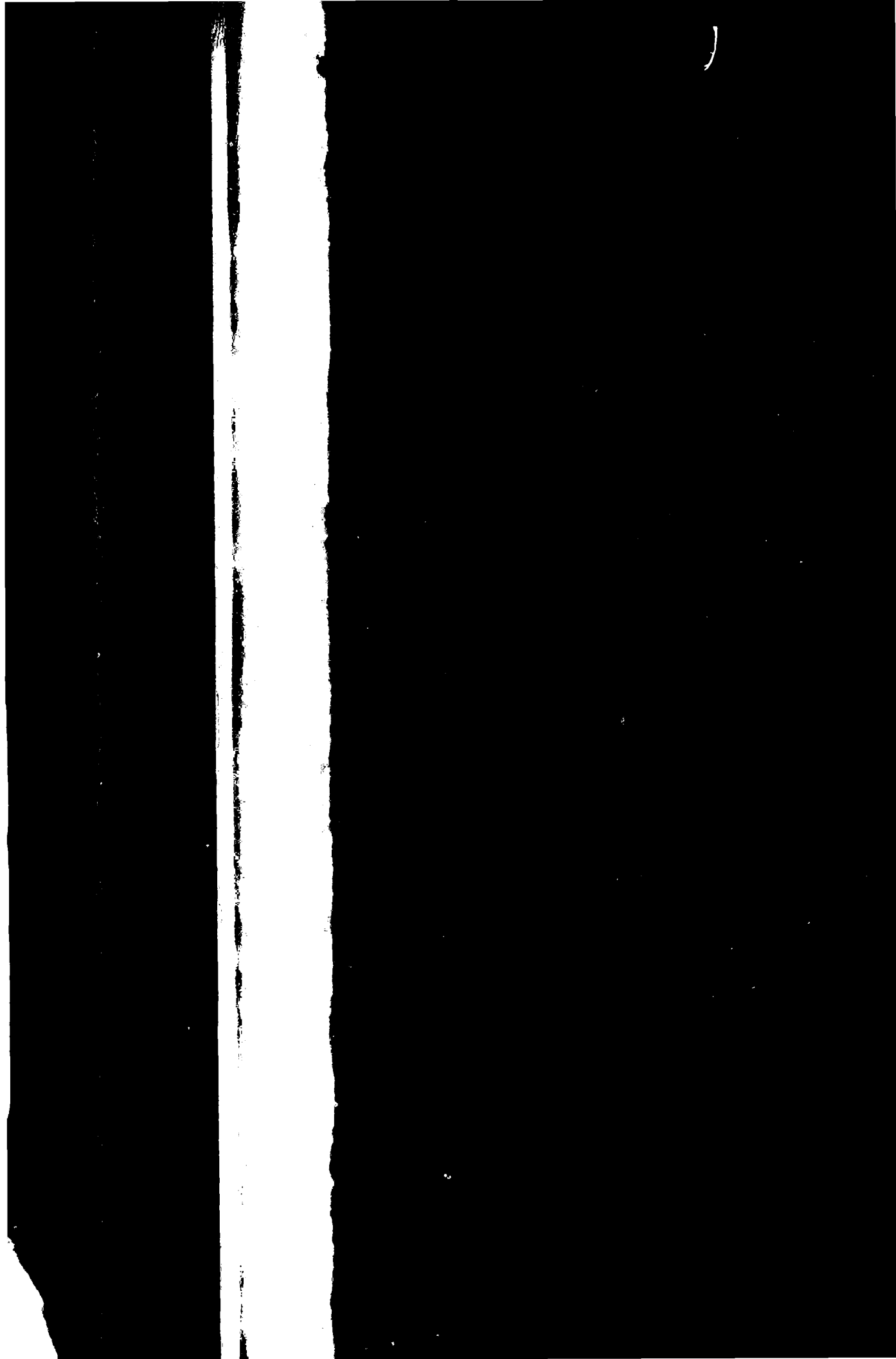
DA  
FILM

existing reinforced  
concrete

SECTION ①

NO SCALE





2